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Costs of Bridges

IN PRESENTING on page 770 comparative costs of various types and sizes of bridges for grade-crossing elimination, compiled from more extensive estimates and data presented by C. N. Bainbridge before the Western Society of Engineers, the Engineering Record assumes, as Mr. Bainbridge doubtless did, that they will be used with discretion. Cost data used in any other manner are a snare and a delusion. Mr. Bainbridge has presumably figured his bridges in accordance with the standards and prevailing conditions on his road. On another road heavier equipment may call for heavier structures, or State laws may require different clearances. In individual cases soft ground may require more expensive foundations, or other local conditions may render Mr. Bainbridge's unit prices inapplicable. For skew crossings, it goes without saying, a multiplier somewhat greater than unity must be used. Nevertheless, used with judgment, and modified to fit individual cases, tables such as these should prove very useful in preliminary comparisons to determine the best way to eliminate grade crossings without working out in detail each possible method of solution.

Road Building in Alaska

CAPTAIN EDGERTON'S article on the building of roads and bridges in Alaska, page 764, deals with problems which engineers in warmer climates are not required to solve. Excessive snow and the great depth to which the ground freezes complicate the usual problems. Where frozen ground is encountered the soil is frequently of a character which makes a stable road impossible during the periods of thaw, and a form of corduroy construction is resorted to as the best means of carrying traffic in the warmer months. The bridge-building and maintenance problems, also, are unusual, by reason of the sudden floods from the breaking of glacial reservoirs filled with water from melting ice and snow. Then, too, the transportation of material is difficult and this necessitates the use of Alaskan spruce except in localities where Douglas fir is obtainable at reasonable cost. Not less interesting than the construction problems are the economics of Alaskan road building, which Captain Edgerton discusses in detail. Estimates of the tonnage carried by the routes have been recorded and in 1914 alone the saving in freight transportation, over the figures prevailing in former days, amounted to almost $1,000,000, or 6 per cent of the total gold output of the territory. This economy is advanced as a justification for the expenditure during the next 10 years of the $7,250,000 for which a schedule has been prepared.

Dollars at Fifty Cents

WATER waste in Chicago received additional publicity last week due to the presentation of a committee report to the City Club. Wholesale metering was suggested, although it was recognized that there is a strong sentiment against it by the uninformed. John Ericson, city engineer, endorsed the report and in a paragraph summed up the situation in Chicago, as well as in every other city where the idea is prevalent that meters, some way or other, promote insanitary conditions. "Every waterworks official with whom I have come in contact," he said, "urges meters as the best and most economical remedy. They differ on whether all the service or only 40 to 60 per cent of it shall be measured. The hardest proposition I have encountered in my Chicago experience [fifteen years] is to get the water pipes equipped with meters. Everywhere there is opposition." Publicity, and that means education of the thinking people, is the means for breaking down the opposition. The waterworks officials are going at it in the right and only way. No further arguments are necessary to convince them of the facts or of the remedy. What they need is an advocate, a publicity man, a promoter to "sell" the facts to the people. From the salesman's standpoint the problem is easy for it comes nearer than any other municipal propaganda to selling dollars at a price of fifty cents apiece.

Unworkable Destructor Guarantees

IT IS not desirable, either for contractors or municipalities concerned with the building of refuse incinerators, that situations similar to those at Atlanta and San Francisco, discussed on page 777, should continue to arise. The proper remedies for disputes and litigation regarding the fulfilment of contract guarantees should be found and applied. If city officials could prepare their own designs for incinerators, as is now being done in Chicago, the burden for the successful operation of the plants would shift from the contractor to the city official responsible for the design. This has not been done in the past because of the pioneer nature of the work, and because many parts of the incinerators are standard and can be used repeatedly. The field has thus been limited to concerns which have been able to offer less costly plants because of their standard equipment and their experience in construction in other places. Only the larger cities can afford to make up their own designs, but it is doubtful if, in the present state of the art, these would result in better plants than could be secured at a less cost under the present contract system. A continuation of the contract system, therefore, requires a fairer statement of the guarantees relating to the sanitary operation of the plant. A change should be made in fairness to the contractors, and the interested public should be satisfied with fair and reasonable protection against nuisances, odors and dust. Without reference to any specific case an unfortunate feature of the present method of stating the guarantees is the opportunity for a local political partisanship to reject plants which, although not fulfilling the letter of the guarantees, have been built in good faith, in accordance with the best practice and which fulfil the intent of the specifications.

Benefits from Highway Propaganda

ONE cannot but admire the energy displayed by the men and organizations promoting the improvement of existing highways into great through routes such as the Lincoln Highway and the Dixie Highway System. Characterized at first as "boomer" organizations, they have demonstrated that with their well-designed publicity and enthusiasm they can secure co-operation and get results where ordinary methods of agitation for highway improvement fail. Aside from the immediate and primary result of these campaigns, the improvement of a given route, there are two material benefits, (1) the education of the people, in the sections traversed, to the value of good roads, and (2) the demonstration that Federal control, financing and construction are not necessary in order to secure satisfactory through routes. No comment is needed on the first of these auxiliary but material results. The second, however, is having an influence that should be clearly appreciated. Probably the readers of the Engineering Record have noticed that the agitation for a national system of highways, built entirely by the Government, has grown much less vigorous during the last two years. This is due to a number of causes, and one of these may be the clear demonstration by the Lincoln Highway Association that co-operation of towns, counties and States can be secured in the construction of through routes without Government control. The views of this journal on the subject of national highways are well known. It believes that in the end results will be much better if money spent locally comes from local sources. The roads will be better appreciated and the development of the highway system much saner than if public funds were poured out and into communities which have helped only insignificantly in raising the money. Then, too, there is the objectionable "pork barrel" feature necessarily involved in the national highways plan. The highway propaganda being carried on by the Lincoln, Dixie and similar highway associations are not to be belittled if they will help in saving the country from an extravagant and indefensible highway program.

Standards of Life vs. Those of the School

IN THE ARTICLE by Sterling H. Bunnell in this journal, May 29, page 688, emphasis was laid upon the impossibility of the college completing the preparation for the student's life work, due to the wide difference between the standards of life and the standards of the school. The difference is patent, but mention of the subject prompts the question whether it is possible to transfer to the school the atmosphere or conditions of professional life. Possibly in an unconscious way various schools have aimed at such a transfer by making their courses more practical, by employing practitioners as teachers and by encouraging the members of the faculty to do consulting work. All of these measures are helpful in a minor way, but they do not give the rigid discipline that comes from measuring a man's work in dollars and cents. The money value of services is the final standard after graduation, and it is manifestly impossible to introduce it in the college giving, what may be termed, the standard type of American engineering education. For graduates of these institutions there must necessarily come the readjustment inevitable to a change of standard.

But while it is not possible to apply the standards of life in our schools as now generally organized, it must not be thought that it is impossible to affect an arrangement whereby the salutary influence of actual working conditions will be felt during the scholastic period. The mention of the work of the engineering department of the University of Cincinnati is proof sufficient that the discipline of life need not be postponed until the student has been sent out with his degree. In fact, it is because of the constant reaction of the shop on the school that Cincinnati has become a veritable laboratory of educational methods. To this reaction is due the character of curricula there developed, the practice of setting a man back at any time in his course if his early work be found deficient and the attempt, through psychological and other studies, to determine the students' aptitudes and thus guide them into lines for which they are best fitted.

It will be contended by some that the academic attitude had best be held inviolate and that its ideals should prevail in the impressionable period and the cold realities of life be reserved for a later date. That contention opens up a broad field for discussion, in which opinion rather than facts will largely govern the arguments of those who enter the lists. It is not proposed to discuss that phase of the question here, but merely to indicate that school standards need not necessarily prevail exclusively until after graduation. One has only to visit Cincinnati and study the work being done there to be convinced of that.

Broad Movement for Engineering Co-operation

AT BUFFALO next week, through the efforts of F. H. Newell, until recently director of the U. S. Reclamation Service and now head of the civil engineering department at the University of Illinois, there will be held a meeting to organize a Nationwide co-operative movement for advancing what may be termed the business interests of engineers. No technical matters will be discussed. The time will be devoted to a consideration of the engineer's welfare and his relation to the world of affairs.

As explained in detail on page 766, the proposed plan involves three chief features. The first is a systematic campaign of publicity, which has for its object the education of the citizens to a larger appreciation of the fitness of the engineer as a manager of public affairs. The second proposal contemplates the creation of a national bureau of advice as to opportunities for engineering employment. The third feature provides for a central agency to deal with prospective legislation affecting engineering interests. Of course other matters, more or less correlated, will not be neglected, but these are the three main issues—publicity, employment and legislation.

The time is ripe for a movement of this sort, and Mr. Newell deserves the thanks of the profession for shouldering the responsibilities of its inception. The plan has not been hastily formed. It has been developing for some time and it was not until Mr. Newell was relieved of his duties as head of the Reclamation Service that he had the time to outline a definite course of action. Many prominent men have been sounded on the scheme and the opinion is unanimous that the movement must be initiated by individuals, rather than by organizations. For this reason invitations have been issued to individuals to consider the first step at Buffalo next week. Once started, however, the movement must receive the backing of engineering societies, both local and national.

In the judgment of this journal, the second part of the program, the establishment of an employment bureau, will be the most difficult to carry out, on account of the inertia of those in need of men. They turn to their crowded application files or rely for help in filling places on the judgment of friends or business associates whom they trust. There is need, of course, for such an agency, a need all the more apparent in these lean times. But while employment fluctuates, the need for publicity and of initiative in legislative matters is always with us. It is to these parts of the program that special attention will be given here.

The publicity work, it seems to this journal can be quite easily organized. There has been so much agitation for publicity for engineering work—a movement in which this journal and its representatives have borne no mean part—that engineering societies, the local ones particularly, are awake to its value. They do, however, need, first, to be shown how to get the desired publicity and, second, to find men willing to give the needed time to the work. The larger societies, such as the Western Society of Engineers, can afford to have on their staffs one man especially qualified to do publicity work.

The organization, if any, leading out of the Buffalo movement might first devote its attention to a propaganda for enlisting the various societies in publicity work, urging the appointment of publicity committees where such do not exist, pointing out the sort of topics that interest the newspapers and the public and going into details as to the methods of preparing press matter. In other words, the central organization would be supervisory in its functions, for the best publicity work is that done locally, with matters of national import, if they arise, done over and given a local flavor. On matters of widespread interest, of course, the central body would furnish the local societies with press material, which they, in turn, after re-editing would direct into local channels. The head office might circularize directly sections not covered by a local organization.

Activity in legislative matters would, evidently, dovetail closely with the publicity work. No proof is necessary that some vigilance committee is needed to guard engineers against vicious legislation affecting their interests. New York engineers, for example, can cite more than one instance where individual initiative at the last minute has barely staved off adverse legislation until the engineering societies, belated, could send reinforcements.

But this would not be its only function—to start engineers and engineering societies on an early campaign against adverse measures. It would also initiate movements for the introduction of measures of an engineering character which would redound to the public good. For example, the National Conservation Congress two years ago adopted resolutions formulating the principles which should underlie sound hydroelectric legislation. Admirable as was the report, there was no machinery for bringing it to the attention of the various States. It has, of course, been used in connection with bills before Congress, but the States have profited only insofar as some individual knew of the report and urged it upon those studying the question.

This is but one instance of many. In the matter of licensing of engineers, State and city building codes, flood control, State supervision of the construction of dams, etc., there is broad scope for the functions suggested in the third part of Mr. Newell's proposal.

Finally there comes the question as to the type of man needed for this work. Manifestly he must be a man of large mold, capable of grasping big situations, of formulating effective plans, of inspiring the confidence of engineers and engineering societies. He must know something of engineering and, above all, be a trained publicist. That means that he must have a nose for news and be versed in serving it to the public in a fashion that the public wants and appreciates.

With such a head, the backing of strong societies and a liberal appropriation—for good publicity work is not cheap—there is a big field for the organization which is outlined in Mr. Newell's proposal.

Preparedness

IT MAY STRIKE some readers as strange that the Engineering Record should publish an article on the need for preparedness for war. It will be remembered, however, that this journal has for months been pointing out the extent to which the present European conflict is an engineer's war and how the organization of a reserve corps of engineers could aid this country in an emergency. Furthermore, if any subject at the present time needs a stauncher patriotism and clearer thinking it is the military responsibility of the individual citizen. When the air is filled with prayers that we may be able, with honor, to stay out of the present conflict, and imprecations are common against the militarism that has brought about the chaos in Europe, the natural inclination is toward retrenchment in matters military. There is needed in such a juncture clear appreciation that preparedness does not mean war, but its very opposite, the insurance of peace; and that soldier-training for our citizens does not necessarily mean militarism.

The Engineering Record, therefore, makes no apology for printing in full the sane, positive views of General Wood on this subject. It deems such publication the height of patriotism, and commends the address to the earnest consideration of its readers—and of their wives, for it is the women who are most apt to hold views that are abhorrent to the idea of military preparedness.

Incidentally General Wood's views are the best answer to those critics of the Engineering Record who have disagreed with its editorials advocating preparedness and an appreciation of the military responsibility of the engineer.

Objection will be made that General Wood's ideas are repugnant to the plan of an international police, advanced as a possible means of permanently insuring the peace of the world. In part they may be, but an international police is not yet assured and we must, therefore, make our plans on the basis of history. There will be time for modification when such a force is established, if that desideratum is brought about. Furthermore, it is not quite certain that the two ideas are actually antagonistic. Certainly an international force would predicate the passing of large standing armies, but a citizen soldiery would, nevertheless, be desirable for backing up with its moral force the comparatively small bodies actually under arms.

The Engineering Record, believes, therefore that men of every persuasion, pacificists as well as militarists, can be brought to common ground through plans such as those General Wood proposed at Worcester. The time is ripe for discussion in order that the voice of the country may clearly be heard when Congress convenes next winter. In any plan that may be adopted engineers will surely not be backward in shouldering their share of the responsibility. The activities of the national engineering societies are evidence of that.

English for Engineers

THE DISCUSSION on page 762 on the standards of life versus those of the schools makes pertinent reference to an investigation, made sometime ago at the University of Illinois, into the teaching of English to engineering students. According to an article by A. F. Comstock in the "Technograph" for April, a committee of the faculty has made two main recommendations. The first is that the rhetoric courses be made a prerequisite for junior standing, and the second that engineering instructors be empowered to report to the rhetoric authorities those students whose written work is unsatisfactory from a rhetorical standpoint. The rhetoric authorities would then prescribe, if they deemed it necessary, additional work in rhetoric, which the delinquent would be required to take preparatory to proceeding in his course and as an additional requirement for graduation.

While neither of these recommendations has been formally approved Mr. Comstock says that there are indications that both will find ready support among the engineering faculty, though he thinks it entirely possible that the second recommendation might ultimately be vetoed, even though approved by the engineering faculty. Its chief interest, therefore, is as an evidence of the stringent measures that the faculty apparently feels justified in adopting in order to insure more fruitful results from the study of rhetoric.

Anyone who has had occasion to examine the literary efforts of students in our engineering colleges or much of their correspondence would heartily approve measures as drastic as the second of these recommendations. It is impossible, without giving offense to college authorities, to express one's self adequately on the English productions of the engineering students. This journal receives yearly a great many applications for positions. With few exceptions their English is abominable. Moreover, about a year ago this journal had another means of judging of the character of English written in our engineering schools, one of the members of the staff acting as judge in a competition for prizes for articles on an engineering subject. Out of some thirty papers examined critically, and coming from thirteen institutions well scattered over the country, not over half a dozen papers were even acceptable, so far as their literary form was concerned. Most of them can be described only by the word "wretched," and in the case of four schools it was recommended that no prize be awarded.

Here, again, reference to the University of Cincinnati is pertinent. There the practice has been in vogue for some years of having all students' reports go first to the rhetoric instructor and then to the appropriate member of the engineering faculty. In this way the students' English from the start is under the supervision of the English instructor. Not only that but every report—and owing to the system in vogue at the University of Cincinnati they are rendered at frequent intervals—is a "theme," and upon a subject in which the student is, presumably, interested and on which he has been obliged to make some personal observations and investigations.

If the faculty of the University of Illinois, therefore, hesitates upon the adoption of the more stringent of the recommendations of its committee it should be able to draw strength for a firm stand by looking into the history of Cincinnati's experiment. It has proved successful and beneficial there. Severe discipline in English is needed, and it is to be hoped that out of the Illinois committee's report a worthwhile system of producing good engineering English will result.

Student Interest in Engineering Societies

TO BIND the younger engineers more closely to engineering societies, several organizations have been in the habit of giving up one night a year to students of neighboring schools. The future of any society lies in its young men, and their futures depend largely on environment and connections made during the first few years after graduation. It is well, therefore, to get these men into the societies during their early professional life. Moreover, the society can probably do more for them then, than at any other time. Commendable, too, is the idea of placing student branches in the schools. This has been done extensively by some of the national societies, and probably next fall will see the step taken by a sectional society, for the Western Society of Engineers contemplates the establishment of a branch at Armour Institute.

What the Armour students think of the idea is expressed in a recent issue of the student publication, "The Fulcrum," as follows:

"The Western Society has that fortunate ability of making students in college feel at home among their superiors in age and experience, with the result that the student gets an insight into the profession which he has adopted, and due to his contact with men who have made a success in the profession, develops a broader outlook upon his life-work."

Close relations are necessary for intensive work with the young, so that it is wise to get hold of the men as early as possible. To develop the ability to "mix" early in the engineer's career, is well worth the effort of any organization, for its own good and that of the profession. Objections as to the possibility of lowering the standards of membership are easily met by arranging proper classification.

SUDDEN FLOODS NECESSITATE FREQUENT REPAIRS TO SMALL BRIDGES

Alaska's Road and Bridge Builders Face Snow, Frozen Ground and Glacial Floods

Unique Problem Is Presented in Construction and Maintenance of Roads, Sled Routes, Trails and Bridges, Aggregating 3663 Miles

By CAPTAIN GLEN E. EDGERTON, Corps of Engineers, U. S. A.
Board of Road Commissioners for Alaska

EXTREMELY heavy snow-fall, with a consequently large run-off in the spring, ground frozen to great depths and covered with moss which prevents its thawing during the summer, common labor which demands wages of from \$2.50 to \$5 per day, with board, unexpected floods from breaks in glacial reservoirs filled with water from melting ice and snow, and a fund of a little more than \$3,000,000 for the construction and maintenance of 3600 miles of transportation routes of all types in a period of 10 years—these are a few of the factors which give to the problem of road-building in Alaska its distinctive features. To undertake the construction of the trunk lines forming the general land transportation of the territory the Board of Road Commissioners for Alaska was created by Act of Congress, approved Jan. 27, 1905. The act provides that the board shall consist of three officers of the Army, one of whom must be an officer of the Corps of Engineers and who is charged with the direction of the field work. The board came into existence in May, 1905. Col. W. P. Richardson was appointed president and has remained in that office ever since.

Main Trunk System

The act creating the board further provides that 70 per cent of the moneys collected for liquor trade and occupation licenses outside of incorporated towns in Alaska should be expendable by the board for road purposes. This provision has since been amended to provide 65 per cent for this purpose, the remainder going to the support of schools and to the care of the indigents and the insane. It was soon evident that the fund would be entirely inadequate and, since 1907, it has been supplemented by congressional appropriations approximately equal to the amount received from the tax fund. The entire expenditure from both funds amounted on Feb. 28, 1915, to \$3,030,015.27.

With this total amount, in the ten years of its existence, the board has constructed and maintained transportation routes of various classifications, with a total length of more than 3600 miles. The main trunk system consists, at present, of roads from Valdez and Chitina to Fairbanks; sled-road extensions from Fairbanks to Ft. Gibbon and to Circle; trail extensions from Ft. Gibbon to the Koyukuk and to St. Michaels, Nome, and Kotzebue Sound, and of a trail from Seward to Nome through the Susitna and Kuskokwim valleys. These routes are the only extensive lines of transportation available for winter use, and they carry the passengers, mail and express from the open ports of Cordova, Valdez and Seward to all the interior of Alaska for 8 months of the year. The area served is about one-fifth the size of the United States, and during two-thirds of the year the sole means of communication with the outside world, except by telegraph, is this road system.

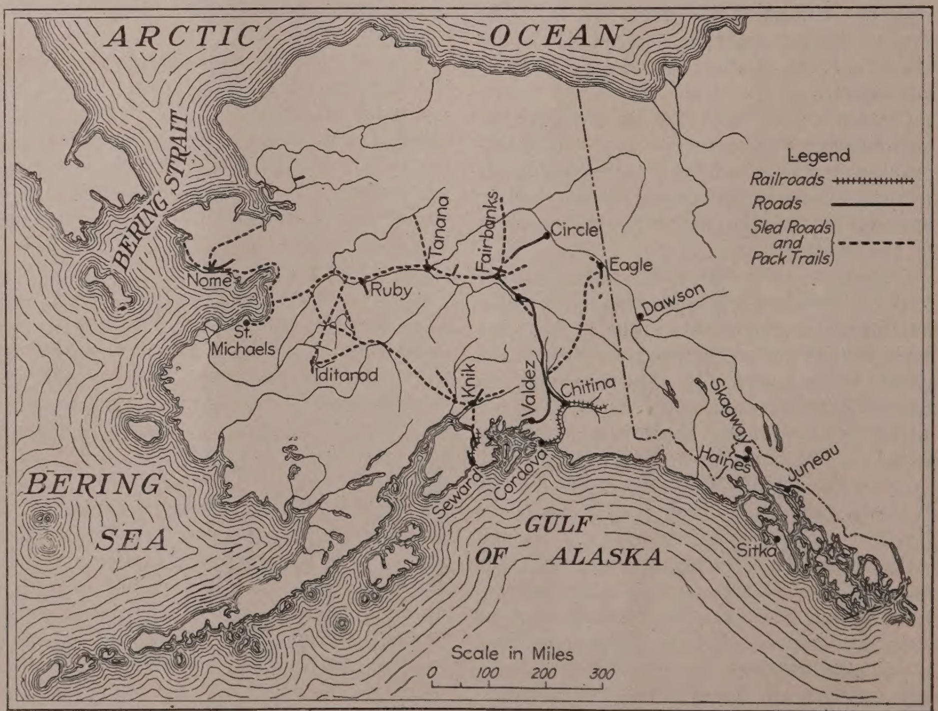
The routes constructed embrace the following classifications and mileage: Roads, 872 miles; sled roads, 582 miles; trails, 2209 miles; total, 3663 miles. The classifications are based upon the travel accommodated rather than upon the cost or character of the construction required.

The routes classed as "roads" compare favorably with rural roads in most sections of the United States, being generally earth roads, cleared, grubbed, graded, crowned, and drained with open ditches and wooden culverts. Some short roads of great importance and carrying heavy tonnage have been graveled, and many sections traversing unusually refractory soils have been corduroyed.

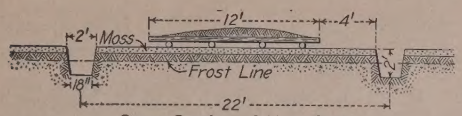
The soil and climatic conditions in Alaska present a wide range of variation and include most of the conditions commonly met in the various sections of the United States as well as other conditions peculiar to countries with extremely cold climates. The two most striking features are the extremely heavy snow-fall, with its accumulation during the entire winter and the consequent heavy run-off in the spring, and the existence of "frozen ground"—ground frozen to considerable depths and covered with moss which prevents its thawing during the summer months. Neither condition prevails throughout the whole of Alaska.

Construction in Frozen Ground

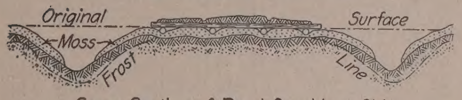
The first of these conditions, the heavy snow-fall, does not affect the character of construction, except to require larger water courses for surface drainage than are necessary except in the very rainy regions of the United States. Where the soil is of suitable nature to provide both good foundation and good surface the second condition, that of frozen ground, is met by the usual kinds of earth road construction. The



ALASKA'S MAIN TRUNK TRANSPORTATION ROUTES AGGREGATE 3600 MILES



Cross-Section of New Road

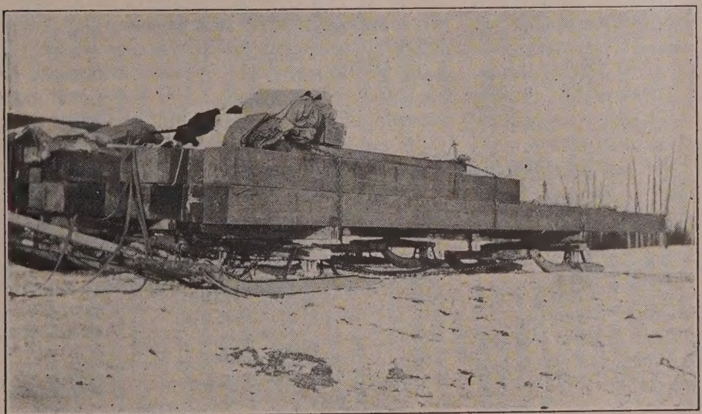


Cross-Section of Road One Year Old

AS SUN THAWS FROZEN MATERIAL ORIGINAL ROADBED SUBSIDES

process of construction is, however, somewhat unusual. The work of the first season is confined to the clearing of the right-of-way, removing the moss covering, and grading to the frost line. During the remainder of the season the sun thaws the stripped ground to a depth of 18 in. or more and the summer frost line is thenceforth lowered slightly each summer. At the beginning of the second summer, the frost line is usually low enough to permit the completion of the grading.

Unfortunately, where frozen ground is encountered the soil is frequently of insufficient weight and consistency to make either an impervious road surface or a stable foundation when thawed. This necessitates the special form of construction shown in the drawings. The original moss covering of the ground is disturbed only at the ditches, which are made narrow and deep for the purpose of obtaining the lower soil, as it is usually more suitable for the road surface than the soil nearer the surface. Corduroy is laid either with or without the stringers as shown, depending upon the evenness of the surface of the ground. If the surface is regular and the moss covering shallow the stringers are omitted. The material from the ditches is thrown to the center in the form indicated and becomes the road surface. The surface of a newly completed road will support ordinary traffic in dry and only moderately wet weather. In very wet weather the wheels cut through the surface to the poles of the corduroy. When ditches are cleaned, the material from them is used to fill the ruts, and the ruts are filled at other times with a drag.



AT LEFT—SLEDS ARE USED TO HAUL TIMBER FOR BRIDGE CONSTRUCTION

The action of the sun on the frozen material in the sides and bottom of the ditches is shown in the lower of the two cross-sections. The moss on each shoulder of the ditch drops, as the material beneath thaws and sloughs away, until the sides of the ditch acquire a gentle slope and are protected from further thawing by the moss left in the berm.

Sled roads are located and constructed like roads in so far as width, grades, and curvature are concerned. They are intended to accommodate bobsleds with four or six horses and any lighter sled traffic that may desire to use them. In the location of sled roads, however, the factor of avoiding locations favorable to the formation of drifts and to glaciation, largely takes the place of good foundation and good surfacing material, so important in road locations. In fact, the surfaces of swamps and lakes frequently offer the best locations for sled roads. When not over swamps or lakes, sled roads require the same grading as roads. They are not, however, crowned or surfaced, since the snow forms the road surface, nor are they ditched or drained except where necessary to prevent their destruction by water during the summer season.

Trails embrace all routes intended for less elaborate forms of transportation than the above. They are usually intended for pack trains in summer or dog sleds in winter and are frequently, but not always, so located that they can serve both. Often they are passable to wagons or to bobsleds but the classification is based upon the highest class of traffic by which they are readily usable.

Trails are cleared about eight feet wide and graded where necessary to accommodate the traffic to be served. Deep gullies are bridged but in summer streams must usually be crossed by fording. Trails intended for winter use are marked with stakes or tripods at 100 or 150-ft. intervals where the position of the trail is not sufficiently marked by the clearing. These stakes make it easy to keep the trail after snow storms and keep travelers from getting lost in blizzards.

AVERAGE COST OF ROUTES

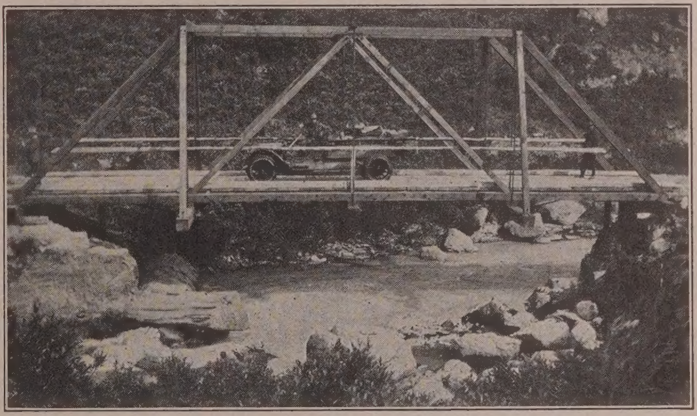
It should be noted that the cost of common labor in Alaska varies from $2.50 per day and board to $5 per day and board. Other expenses incident to construction work are in proportion, so that the cost of completed work in Alaska is from two to three times that of similar work in the United States. The average cost per mile of all routes constructed to date is as follows: Roads, $2484; sled roads, $229; trails, $98.

Not the least difficult of the problems met in the construction of these roads has been the bridging of the northern rivers. Generally speaking, the rivers of Alaska may be divided into two classes, those fed chiefly by glaciers and those fed chiefly by rainfall and melting snow. The former carry little or no water in the late fall, the winter, and the early spring. They reach their highest stages in the hottest days of summer. Many of these streams are so sensitive to temperature changes that during the summer months they have quite regular diurnal variations in stage, the highest water lagging behind the maximum temperature a few minutes or a few hours depending upon the watercourse. These fluctuations are in some cases so great that experienced travelers attempt to ford certain streams only at favorable hours.

FLOODS MENACE BRIDGES

The great danger to bridges over streams of this class arises from the formation and bursting of reservoirs in the feeding glaciers, formed by depressions or cavities in the ice. The floods thus produced are often of great magnitude and can rarely be anticipated.

The rivers fed chiefly by rainfall and melting snow have high stages in the spring, from the melting snows on their water sheds, and during the summer months, depending upon the rainfall. The spring floods come before the ice in the rivers is melted and cause the familiar "breakup," in which the ice is lifted by the rising waters and is carried out by successive jams and rushes. The rushes are often of tremendous force and are very destructive, not only to structures in the flood channel, but frequently to the banks of the channel itself, while the temporary dams formed by the ice occasionally cause very unexpected changes in the courses of the rivers.



AT RIGHT — TYPICAL FORM OF DOUGLAS FIR TRUSS FOR 60-FOOT RIVER CROSSING

The difficulties of the bridge designer are greatly increased by the absence of data concerning the frequency and magnitude of these phenomena. Except for a few hunters and trappers, the interior of Alaska has been occupied only within very recent years; and not only is the population new and sparse, but it is made up of people with such migratory habits that three or four years' residence in a single place entitles one to speak authoritatively on weather conditions. In ten years one's freedom to indulge in reminiscences of the "early days" is unquestioned.

The pier most suitable to the requirements of stability and to the funds available in the past, has been found to be a pile-and-crib pier. The superstructure of the bridge is supported by pile bents surrounded by rock-filled log cribs, with a wedge-shaped up-stream nose inclined at an angle of about 45 deg. and in many instances protected from abrasion by a railroad rail. On soft foundations the tail of the pier is also given a wedged shape to destroy the effect of the suction eddy. The bents, within, are not attached to the pier but are protected by it from injury by ice or log jams, and by its settlement or the settlement of its rock filling, from undermining.

DESIGN FACTORS FOR SPRUCE BRIDGES

The superstructures have usually been of the Howe truss type for spans of 30 ft. or longer. The trusses are of wood except the tension web members which are steel rods. The wood used is native Alaskan spruce or Douglas fir. The former, though extensively employed, is used only when the cost of transportation of the latter is prohibitive.

Experience with these bridges indicates that good sound Alaskan spruce may be considered to have about the following working strengths, in pounds per square inch: Maximum fiber stress, bending, 700; maximum tensile stress, 700; shear parallel to grain, 100; compression, perpendicular to grain, 125; compression, parallel to grain, 700.

Spans up to 108 ft. in length, of Alaskan spruce cut and hewn on the ground, and erected while the timber was still green, have given reasonable satisfaction when large allowances for camber were made. The life of the timber in these trusses appears to be about 10 years.

Douglas fir is used for truss members where obtainable at reasonable cost and in all cases for spans of more than 108 ft. in length. Spans of 150 ft. in length have been built with this material. For longer spans steel-cable suspension bridges have been constructed. Neither fir trusses nor suspension bridges can be used in the interior regions on account of the high cost of transportation, so the interior rivers that require spans greater than 150 ft. in length have had to go unbridged.

A MILLION-DOLLAR SAVING

Estimates of the tonnage passing over the various roads, sled roads and trails have been kept and recorded, as well as the cost of transportation on each route. The construction or improvement of a road has always resulted in a large decrease in the cost and usually in a considerable increase in the amount of the traffic using it. In 1914 the total savings on the cost of freight, using roads constructed by the board, over the cost at the rates prevailing in each instance when construction was started, amounted to $986,000. This amount is 6.2 per cent of the total gold output of the Territory for the same period, and is 5 per cent of the total mineral output. These figures are exclusive of passengers and of mail.

A program of expenditures required to complete the road system of Alaska, as justified by the present development and rate of progress, has been prepared in the office of the Board of Road Commissioners. This program, covering a period of ten years and calling for $7,250,000 in that time, has been recommended officially and it is probable that the near future will see its authorization by Congressional action. Of the total, $7,250,000, required, about $1,000,000 can be expected to accrue from taxes collected in Alaska under the provisions of existing law, so that provision for about $6,000,000 additional is necessary.

The additional funds can properly be appropriated from the National treasury. If the appropriations during past years for road construction in Alaska are considered as expenditures for the purposes of developing a large and productive field of commercial enterprise for the citizens of the nation, the same justification exists for increasing these appropriations to secure the maximum economical development for the industries this country is capable of supporting. The precedent for this policy has been established elsewhere, notably in the bond aid and land grants of the western railroads, in national aids to roads and railroads in the Philippine Islands, and, lately and conspicuously, in the work of the U. S. Reclamation Service.

If, on the other hand, it is held that only the people and industries actually located in this Territory should pay for its development, they can well afford to do so. They owe to the present road system a saving of nearly one million dollars for the year 1914 alone. This amount is only slightly less than the maximum sum required in any of the program years, and it is a burden these industries can well afford to assume for 10 years rather than pay in the excessive cost of primitive transportation an equal or greater tax forever.

Engineers Will Discuss Plans for Nation-Wide Cooperative Movement

Through Efforts of F. H. Newell a Campaign for Benefit of Profession and Public Will Be Launched at Buffalo Next Week

PLANS for the organization of a cooperative movement among engineers, dealing not with technical problems but with the engineer as a citizen, wage-earner or employer, will be discussed in Buffalo on June 23 or 24, during the period of the meeting of the American Society of Mechanical Engineers in that city. The meeting is the outcome of the efforts of F. H. Newell, formerly director of the U. S. Reclamation Service and now head of the civil engineering department of the University of Illinois. Mr. Newell has been discussing the subject with many members of the profession for months past and the consensus of opinion seems to be that the time is ripe for doing a real service to the profession.

OBJECT OF MEETING

The object of the meeting at Buffalo will be to decide upon a definite course of action for the advancement of the material welfare of the engineers of North America, both individually and collectively, as distinguished from the more purely scientific and technical work of existing organizations. This object is to be attained by intelligently directed and systematic education of the public, through the public press and otherwise, to a larger appreciation of the fact that the engineer, as a manager of civic affairs, is the best servant of the people and that in industrial matters he is to the highest degree efficient and trustworthy. The individual engineer will gain by such activity, not merely through the general education of the public and through the systematic building up of correct opinion, but should find in this cooperative effort a direct, personal gain, first, as an employee, in the larger opportunities for employment; and, second, as an employer in the opportunities of securing impartial advice concerning needed assistants.

The methods proposed are to utilize as far as possible the facilities which may be provided by existing engineering organizations, encouraging the building up and strengthening of local engineering societies as well as the national societies, working through and with these along all lines which have to do with those interests of the engineer which are not strictly technical or scientific. It is proposed to supplement and coordinate the agencies and activities now existing on the theory that the great national associations are more or less exclusive in their membership, carefully sifting and considering all applicants, while the local societies are, or should be, inclusive in admitting to membership everyone locally interested in engineering work. It has been found, for example, that the local societies, organized merely as branches of one or another of the national societies, do not fully meet local needs, whereas, when changed into inclusive organizations they have rapid growth and perform larger functions. It is also found that the local societies, thus constituted, aid in stimulating membership in one or another of the national organizations.

COOPERATION WITH SOCIETIES

It is assumed and hoped that each of the national engineering societies will cooperate, furnishing to a central cooperating office all information on matters which pertain to the advancement of the engineering profession as a whole, and aiding in those details of employment, publicity, etc., which fall within the proper cognizance of the proposed cooperative organization.

It is assumed that the secretary of each local society will keep in touch with a central office, furnishing a list of membership, and supplying any needed information, not only concerning the qualifications of individual members, but also upon all matters which are of interest, from the business standpoint, to engineers in general.

Headquarters should be established at some central point where the work may be organized and practical demonstration made of its feasibility.

EMPLOYMENT

It is proposed to afford opportunity for bringing together in one place the requests which come to many large employers, such as to the U. S. Reclamation Service, for advice concerning opportunities for employment, treating these confidentially, if so desired, and considering them in connection with the similar requests for advice as to opportunities offered. For example, in employing large numbers of engineers it has been found that many men write asking for information regarding opportunities in general or in particular, and others ask for advice as to securing the services of young engineers or of the best consulting expert to be had on certain lines. There appears to be a great need of a systematic and businesslike handling of these important details—of fitting the square and the round pegs into their proper holes.

The experience acquired by various existing organizations along these lines justifies the belief that a central body with no ulterior object in mind, and which commands the respect of the engineers as a profession, will be of indescribable benefit to the individual engineer.

PUBLICITY

The proper publicity regarding the achievement of the engineering profession has not been attained, nor have systematic efforts been made to present to the public in general, through the medium which reaches the public, the opportunity for proper appreciation of the great results which have been and are being accomplished. The technical press is taking this up, but unfortunately the various engineering magazines do not reach the great body of the thinking public to a degree at least consistent with the importance of the subject.

Experience had in handling the publicity side of Governmental, engineering or scientific bureaus shows that under good auspices valuable results may be attained in building up the scientific work, and leads to the belief that a well-devised system for the whole engineering profession will go far to bring about an increase in the material welfare of the engineers individually and collectively. Unless the engineers put forward such well-organized effort, strictly confined, of course, to the highest conception of professional ethics, they must necessarily fall behind.

The public does not carry these matters long in mind, and quickly forgets the striking incidents and important conclusions unless these are presented daily in attractive form. The mere recital in technical language of a great achievement fails of its object in that the public does not have the knowledge or imagination to appreciate the magnitude of the achievement and must continually be apprised in simple, concise form of the real meaning and relative value of the results attained in the overcoming of obstacles.

LEGISLATION

The criticism has been made that engineers and engineering societies have not given to public affairs and to proposed legislation the amount of attention consistent with their duties as citizens or their opportunities as educated and broad-minded men. There has been a very proper desire on the part of the technical societies to avoid expressing opinions, especially on matters not immediately connected with the objects of the society, but this has frequently been carried to an extreme such that the public and legislative bodies have not had the assistance which should be volunteered by engineers. To overcome some of the objections, and to enable the engineers as a whole to perform their duties in this regard, the suggestion has been made that the central cooperating organization can take up matters of municipal, State or Federal legislation and give to the local societies information or advice regarding methods or results attained. There is unquestioned need of a proper activity in this regard and an opportunity for useful public service.

There is need of a man of experience, enthusiasm and energy to visit periodically the local engineering societies in each large city or important center, diffusing the useful experience already attained in strengthening such societies and in stimulating cooperative effort. At the same time he should point out the broader needs and opportunities, and encourage the building up of the spirit of cooperation and of public service among engineers in general. There are many important centers of population where local engineering societies are languishing, or where broad, inclusive societies should be started. Much can be accomplished by calling upon the principal men, showing them the form of organization which elsewhere has been found most effective, and supplying them with advice as to how to go about the formation or strengthening of the local societies.

FINANCES

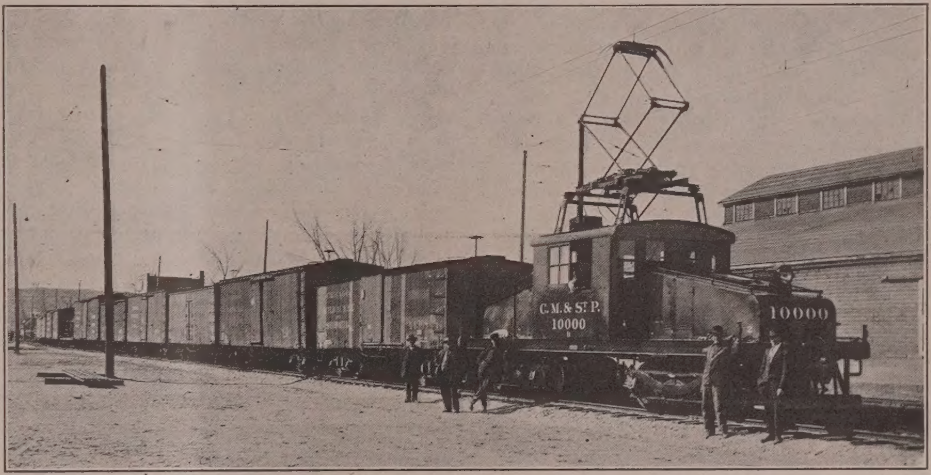
In order to start a cooperative movement of this kind it is necessary that some one man, or small body of men, devote considerable time or energy to overcoming the natural inertia. When once started, however, the expenses can probably be readily borne by contributions from the cooperating organizations and through registry fees charged to individual engineers seeking employment. The expressions already received from engineers as to the need of such cooperative movement are such that it is believed that there are a sufficient number of persons interested to initiate the work.

WOODEN SMOKE-SHEATHING, for protecting the iron-work of the bridge over the Philadelphia & Reading Railway at Broad Street and Lehigh Avenue, Philadelphia, increased the corrosive action of the locomotive gases instead of retarding it. According to the 1914 report of William H. Connell, chief of the Bureau of Highways, the gases eventually found their way into the enclosed area where, without free access of air, deterioration proceeded until many of the girders and floorbeams were so reduced in section as to appear almost unstable from their dead weight alone. The policy of the bureau hereafter will be to eliminate sealed-in sheathing and to depend for more efficient maintenance upon frequent painting and the installation of cast-iron or steel-plate protection, directly over the tracks.

Great Falls Terminal Line Now Electrically Operated

Change on 4-Mile Link Is Incidental to Main-Line Electrification Program of Chicago, Milwaukee & St. Paul in Montana

AS A FORERUNNER of its 3000-volt, main-line electrification in Montana the Chicago, Milwaukee & St. Paul Railway has recently begun electrical operation, by a single 50-ton electric locomotive, of the terminal line in the city of Great Falls, which is at present the terminal of the new 138-mile feeder line to Lewistown and thence to Harlowton, the eastern terminus of the main-line electrification.



ONE 50-TON ELECTRIC LOCOMOTIVE NOW HANDLES TRAFFIC ON 4-MILE TERMINAL LINE AT GREAT FALLS, MONTANA

The Great Falls terminal yards are located in the center of the city and are connected by a crosstown line, about 4 miles in length, known as the Valeria Way Line. There are about 3 miles of additional electrified trackage, making a total of 7 miles. The tracks connecting the Falls yards and the terminal yard pass through the business part of the city, and it is expected that considerable benefit will be derived from the elimination of locomotive smoke from the center of the city, as well as a reduction in the cost of train haulage. The traffic includes, beside the transfer of both freight and passenger trains from the Falls yards to the terminal station, switching service in the terminals. The locomotive, a view of which is shown, is of sufficient capacity to take care of 580-ton freight trains running about 9½ miles per hour on the maximum grades of 0.65 per cent. It operates at 1500 volts, getting its power from the hydroelectric plant of the Great Falls Power Company at Rainbow Falls, about 6 miles away.

The work was done by the electrification department of the Chicago, Milwaukee & St. Paul Railway, with R. Beeuwkes engineer in charge, under the direction of C. A. Goodnow, assistant to the president. All of the electrical apparatus, including locomotive, substation equipment and line material, was furnished by the General Electric Company.

THE LOUISVILLE FILTERS removed 11.3 tons of clay and silt per day in 1914. The old filters required 2.97 per cent of wash water and the new filters 4.55 per cent. Sulphate of alumina to the extent of 1.03 grains per gallon was used.

Military Preparedness an Insurance for Peace, General Wood Tells Engineers

At Fiftieth Anniversary of Worcester Polytechnic Institute, Commander of Eastern Department, U. S. Army, Impresses Technical Men with Need for Training in Arms

A PLEA for the introduction in the United States of the Swiss military system, the essence of which is not a large standing army, but a citizenry thoroughly trained in the use of arms, was made by Major-General Leonard Wood, commanding the Eastern Department of the U. S. Army, and until recently chief of staff, in an address last week at the celebration of the fiftieth anniversary of Worcester (Mass.) Polytechnic Institute. While military preparedness is not, strictly, an engineering subject, it is one in which engineers and engineering societies have, of late, manifested unusual interest, for the war in Europe has demonstrated more forcibly than has any previous conflict, that the success of all large-scale operations of attack and defense, as now conducted, depends largely upon technically trained men. In fact, many of the national and local engineering societies in this country have committees at work devising plans whereby the special knowledge of their members could be used to its fullest advantage if the United States should ever be forced to call upon them for their services. Under present conditions, therefore, General Wood's remarks carry a direct appeal to the engineering profession, and his address is here reproduced in full:

WAR DEMANDS TRAINED MEN

"I sometimes think that people in this country do not quite understand the real function of the soldiers and sailors. You know our business is not to make war. Our business is to conduct the wars that you people get us into. Your industry and your trade, in your struggle for commercial control—not your individual struggle, but the struggle of commerce throughout the world —is the cause, and has been the cause, of nine out of ten of the wars since history was written. Soldiers do not make war. War is made by commerce and trade. Governments declare it, and armies have to try to conduct it and terminate it in the best possible way for their own governments.

"If anyone proposed to President Elliott of the New York, New Haven & Hartford Railroad to have a million untrained men take charge of the trains and turn over to them all the railroads in the country I do not think that he would expect that they would be well run, or that they would be free from collision and all sorts of accidents. And yet, in your entire forgetfulness of the military side of your obligation that condition of unpreparedness has gradually arisen which comes about in all countries following long periods of development, commercial and otherwise, which is oftentimes very dangerous.

"You know, in the days of our fathers, in the days of our early presidents, our people were constantly being warned of the value of preparedness. And even as conservative a man as Thomas Jefferson said, in one of his letters to Monroe, that we must train and classify all of our male citizens and make military instruction obligatory in all our colleges, saying in conclusion: 'Until we have done this we never shall be safe.' In other words, he realized the necessity of preparation. Practically every message of Washington was full of the same words, and Adams very tersely said: 'The only way to maintain peace is to be prepared for war.'

"Those are utterances of men living at a period when transportation was very crude and when the means of transport over sea was slow and difficult, when the weapons of the people were simple, when the knowledge of them on this side of the water was rather general, when there were no large standing armies on the other side. Armies had to be gathered together and moved with great slowness and care. Our own people were skilled, more or less, in the use of arms, which were very simple. They were literally made over night. And now you have a condition, without any reference to what exists abroad—I am speaking in general terms—under which transportation has divided distance by ten, and preparation has probably been multiplied many times. The weapons of war are intricate. It takes a long time to make them, and a long time to learn how to use them. So you have on the side of the prepared aggressor tremendous advantages—rapidity of approach, completeness of organization, familiarity with weapons. You have, on the side of the unprepared individual, a short time to get ready, lack of organization, weapons to be made, and the use of them to be acquired.

PREPAREDNESS AN EFFICIENCY MEASURE

"Everything is in favor of the prepared, and everything against the unprepared, and it is the part of common sense, and only small tribute to your intellectual efficiency, to recognize that fact. You don't need to go into details, but those are the facts of to-day, and they should be recognized, and we should cultivate in this country, in the heart of every boy and man, a sentiment of individual responsibility towards the State in time of war. There is a great deal of attention given to the development of the child and of the man. Very little is said to him about his soldier responsibility to the State, and without the proper sense of soldier responsibility no State can live, and that is the sentiment that we want to cultivate in this country. It is not enough to be willing to do a thing; you have got to be prepared to do it efficiently.

"In this age, if there is any one word that is the foundation of success it is efficiency. Efficiency in military matters is infinitely more complex than efficiency in any civil profession, because it carries with it not only the handling of intricate machines, the moving of large numbers of people, their supplies, their care when they are sick, the use of all sorts of implements of destruction, and the use of means of defense against them, but also the study of mental characteristics of men, the methods of handling them.

"All the great questions of campaign are tremendously intricate, and if there is anything in the world that requires thought beforehand it is the question of preparedness—not preparedness for war; do not always get that in your head. It is preparedness *against* war, and insurance for peace, and it is the best of insurances. There is no insurance nowadays that is worth much unless people are prepared and know what they are going to do. There is no sentiment in this country for a large standing army. There is no sentiment for it in the army itself. There is, however, a strong sentiment for an intelligent preparedness and the organization of the resources of the country, so that we shall know what they are, where they are, and how they shall be used. All that is quite consistent with our ideas.

BIG ARMY NOT WANTED

"We do not want a big army. We want a small, good, standing army, sufficient for the peace needs of the nation, and by that I mean the garrisoning of foreign possessions and the building of great engineering works like the Panama Canal. Such an army must be backed by an adequate reserve. Ten reserves can be maintained at the cost of one man with the colors. Our army is maintained in time of peace at less than half its war strength. The mobile army of the United States is only twice the number of the police force of the city of New York. The militia is a little stronger, but it is maintained at half its strength, without reserves. The reserves would little more than double it, and these reserves should, of course, be provided.

"After the regular army and militia on land come the volunteers. The volunteers have to be commanded, and a million volunteers—and we had a million volunteers at the end of the Civil War—would require about 35,000 officers who must be prepared in advance, and they cannot be developed over night—not in these days of intricate weapons.

You also need a strong and adequate navy, a good one, as good as any in the world, and back of it the necessary reserves of men and material, just as in the army. Those are the things that the army and navy, I think, are both working for. I do not think you have any more conservative people in your population than the officers of the army and navy. We know something of the responsibilities of the game. Some of you do, and some of you do not, but we do not want to see the American people brought into a condition of war—of which we see no evidence today, but I am speaking of possibilities, and you must judge the future by the past. We do not want to see them brought into war unprepared. It is a false, it is a 'fake'—if I may use that word—humanity that fails to recognize facts, and make necessary preparation. It means the loss of thousands of men, simply because they are not ready; and preparation, as I have said before, is the best possible means of averting trouble. Do not think for a moment that the people of the world do not know our exact condition, for they know it to the last dot.

SWISS SYSTEM A MODEL

"Now, we want to develop a certain interest in military matters in the schools and colleges of this country, and if I were going to voice the sentiment or the policy to govern our military affairs, I should say, look to Switzerland as perhaps the best example. The policy would be to have the smallest number of men with the colors; and the largest possible number of men leading normal lives, but who have received enough training to be reasonably efficient soldiers when they come to the colors, because the days of a highly trained military army are past, absolutely. You must have highly trained officers, and many of them, and a good standing army. But the armies of to-day represent the people of a nation. And it is a singular thing, as we go back into the papers of our early presidents, to find them dwelling constantly on one thing, the necessity of an efficient and well-trained militia. What did they mean by that? They meant men between eighteen and forty-five years of age, and they hoped to have them systematically and regularly trained. In other words, they were thinking of a condition not unlike that which exists in Switzerland to-day, where every man has had training and is leading the life of a quiet citizen, but is ready to be an efficient defender of his country—and it is a mighty sight better to be an efficient one than only a ready one.

"Can you men, particularly college men, look back to your athletic days and conceive of a football season coming on, and all your men refusing to train for the team, but all of them saying: 'We will play when the other team comes; we have a natural aptitude; we don't have to train'? (Laughter.) You have had experience enough in football to know that that would be idiotic. Some of us have looked enough into the history of war to know that that is a game where we must be ready. People sometimes say that we will be ready for war when it comes. That we can be ready in a minute is just as foolish and infinitely more dangerous. I want you to get that idea out of your head.

"We do not want militarism in this country, but we do want the American people to wake up, and realize that a logical, sound system of preparedness should be inaugurated—one which will be consistent with our ideas, one which does not mean a large standing army, but an adequate navy, an efficient army and excellent militia, both supported by reserves, and a body of trained officers who can be assigned to the volunteers. When you think you have to raise 35,000 officers you can realize how very essential it is. The officers of the regular service are about 3,600 only, and in the militia only about 7,800, and you cannot take many away without crippling those services. You have to prepare an enormous body of officers, and the question is, how are you going to do it?

SCHOOLS CAN CO-OPERATE

"We have at schools in this country to which officers of the United States Army are detailed some 42,000 students receiving military instruction. I refer to those colleges and schools which have been passed by the War Department, and whose military instruction is considered to be reasonably satisfactory. We have proposed several times to take a number of these graduates. We ought to take a thousand of the nine thousand who graduate every year, and commission them for a year in the regular service. All of these schools are of the collegiate class. We should commission these men for a year, and give them the pay and allowances of a second lieutenant, which is $2,200—worth about $1,750 in money, and the rest in allowances. Then, at the end of the first year's service, they are commissioned regularly as United States Reserves, and will serve until they are thirty-two years of age. You can also get many men from these college camps—that is, the university boys taking a course of military instruction in the camps. We hope they will take their five weeks each year. In many universities they follow courses in military history and art. The young men who come to these camps are of most excellent quality. They have volunteered to pay their own expenses. They have made records that have completely surprised our officers. At Burlington last year of the men who shot 63 per cent qualified as marksmen, and better. That is a record that is quite remarkable, and is somewhat more than double the militia record. It shows what you can do with intelligent young men. These men have all been urged to go into the militia.

MILITIA NEEDS SUPPORT

"The organized militia is with us to stay, and it is your duty to back it up, and I think that every man who employs labor, whether it be skilled or ordinary labor, should, if a man is a member of the militia, remember it, and not discriminate against him. The general policy is to discriminate against the militiaman. He has all sorts of obstacles to overcome. The labor unions are against him and discriminate against him, and because he has to go away every summer and take his training in the militia he is discriminated against by employers. The militia will be just as good as you want it to be. We are trying to put a regular officer with every regiment of militia, and one with every squadron of mounted troops, and when we get a few more officers we shall be able to complete the assignments in the country.

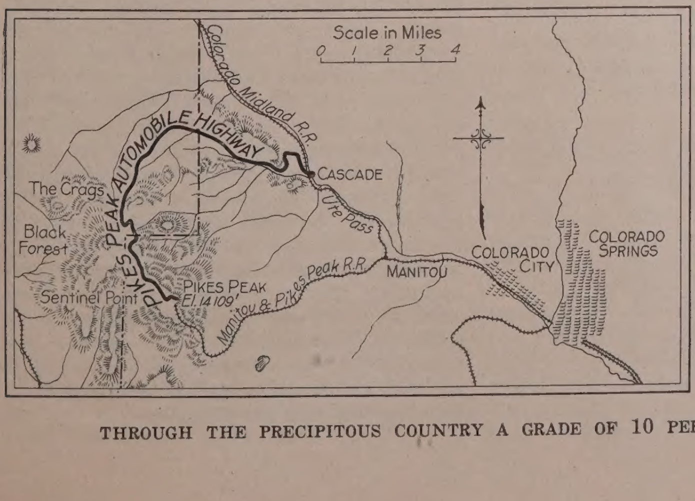
"We are doing everything we can to start rifle shooting in the public schools, and to build up in the schools throughout the country an interest in military training. You need not be afraid of it. The little republic of Switzerland shows no ill results from this policy. It has a murder rate a little less than one-eleventh of ours. Military training does not seem to have debauched the youth of that country. Australia has recently started military training. The cases of disorder in the juvenile courts and the criminal list in the higher courts have markedly decreased. In other words, military training teaches men that they have a responsibility to someone. They learn to know the flag of their country. They learn to do things promptly and thoroughly, and as and when told. It adds to their economic efficiency. They are better physically, and they are better morally, as you will find from looking over the statistics in nearly all countries, where such training is in vogue, that the criminal rate is lower.

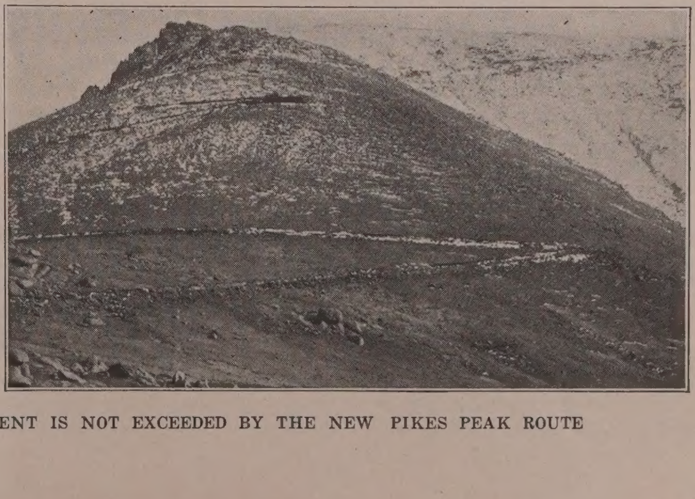
"I think that if we could get established, eventually, in this country something on the line of the Swiss system we could maintain ourselves without undue stress of any sort. We should have a citizenry really skilled in the use of arms, ready to defend the country effectively, and we could do it without in any way departing from our ideals. And my personal opinion is that that is the line on which we must develop. In the meantime, we must back up our army and navy and the militia. We must start this military training in the schools. We must have this body of officers so that if we ever have the misfortune to become involved in war we shall at least have enough officers for the training of the volunteers."

New Automobile Highway Ascends Pikes Peak

Construction of 17-Mile Scenic Road 20 Feet Wide up Mountain from Colorado Springs Is to Be Finished July 15

LINKING Colorado Springs with the summit of Pikes Peak, Colorado, 14,109 ft. above sea level, the new 17-mile highway, now under construction, will be the highest automobile route in the world, according to the claims of its builders. The precipitous country traversed makes the building of the road a difficult task inasmuch as a grade of 10 per cent is not exceeded. The route will be along the old carriage road to the summit. The new highway will be extended to a width of 20 ft., except at bridges, and involves a large amount of side-hill construction with numerous retaining walls of dry rubble masonry. The accompanying map shows the tortuous course followed. At many gulleys and ravines Armco metal culverts, with concrete aprons where the ground is





THROUGH THE PRECIPITOUS COUNTRY A GRADE OF 10 PER CENT IS NOT EXCEEDED BY THE NEW PIKES PEAK ROUTE soft, will be used. Large depressions will be crossed by concrete bridges.

As the scenic features will be the important inducement for automobilists who use the route, there will be provided large turnout or view stations. According to information received from R. Hardesty, President of the iron culvert and tank manufacturing company in Denver which bears his name, a large force of men and teams is now at work on the project and it is planned to open the route to traffic on July 15. The Pikes Peak Auto Highway Company is promoting the construction and A. G. Allan is chief engineer.

Compares Costs of Bridges for Grade-Crossing Elimination

C. N. Bainbridge, Before Western Society of Engineers, Gives Estimates for Various Types of Under and Over Crossings

DISCUSSING in a paper presented June 14 before the bridge and structural section of the Western Society of Engineers the broad questions of the general manner of eliminating grade crossings—whether to carry the streets under or over the tracks, and the types of bridges to use—C. N. Bainbridge, office engineer of the Chicago, Milwaukee & St. Paul Railway, presented approximate costs of various types of bridge structures for 60, 66 and 80-ft. streets. The five accompanying tables have been compiled from more detailed information given by Mr. Bainbridge in his paper, and notes from his discussion of the advantages and disadvantages of the different types are also here presented.

TABLE 1—DIFFERENT TYPES OF BRIDGES AVAILABLE FOR GRADE-CROSSING ELIMINATION

Type	General features	Remarks
		Railroad Over 60, 66 or 80-Foot Street
A	Single span	
B	Two spans, bent in center of street	
C	Three spans, bents at curbs	Centers of curb bents 10½, 9½ and 16½ ft. respectively, from face of abutment for 60, 66 and 80-ft. street; 36-ft. roadways for the 60-ft. streets and 44-ft. for the others.
D	Four spans, curb and center bents	
		60 or 66-Foot Street Over Railroad
E2	Single 29-ft. span over two tracks	All 60-ft. bridges designed for 12-ft. sidewalks and 36-ft. roadway; all 66-ft. bridges designed for 11-ft. sidewalks and 44-ft. roadway, including double-track car line.
E3	Single 42-ft. span over three tracks	
E4	Single 55-ft. span over four tracks	
E6	Single 81-ft. span over six tracks	
F2	Three spans over two tracks	Bents alongside tracks, 29 ft. face to face; natural slopes beyond bents, with low abutments at tops of slopes. All clear spans 29 ft.
F4	Three spans over four tracks	Same location for bents and abutments; abutments and slopes carried down part way to allow one track outside each bent, on 18-ft. centers with interior tracks.
F6	Three spans over six tracks	Same arrangement, with abutments carried down full depth to allow two tracks under each span.

TYPES

Table 1 indicates the type of bridge and the general dimensions for different cases.

TABLE 2—ESTIMATED COSTS OF RAILROAD BRIDGES OVER STREETS

		60-Foot Street		66-Foot Street		80-Foot Street	
Type	Material	Two tracks	Each additional track	Two tracks	Each additional track	Two tracks	Each additional track
A	Steel	$16,400	$6,000	$18,000	$6,700	$21,700	$8,200
B	Steel	15,000	5,400	16,500	5,800	19,200	6,900
C	Steel	15,500	5,500	17,100	6,000	18,800	6,800
D	Steel	14,900	5,100	16,000	5,500	17,800	6,300
D	Concrete	12,500	4,200	13,400	4,500	15,000	5,300

TABLE 3—ESTIMATED COSTS OF STREET BRIDGES OVER THE RAILROAD

Type	60-Foot Street		66-Foot Street	
	Steel	Concrete	Steel	Concrete
E2	$12,900	$11,400	$15,100	$13,200
E3	14,700	13,200	17,100	14,700
E4	*17,800	......	*21,700	......
	†16,400	......	†19,600	......
E6	*24,200	......	*29,800	......
	†22,000	......	†26,500	......
F2	17,500	14,200	23,700	17,200
F4	20,500	17,100	27,000	20,400
F6	21,600	18,200	28,200	21,600

*Without center girder
†With center girder.

All track-elevation bridges are two-track structures designed for Cooper's E-50 loading, with center girders, and track and girders 13 ft. on centers. The floor depths are 3 ft. 6 in. for the steel bridges and 3 ft. 10 in. for the concrete. The steel bridges are figured with I-beam and concrete-slab floors. The abutments and pier footings are figured on the basis that the foundation is good for from 2 to 2½ tons per square foot. The overhead bridges are designed for a 24-ton concentrated load on two axles of 5-ft. gage, 10 ft. on centers, and two 40-ton street cars, together with 150 lb. per square foot on the remainder of the bridge. The clearances are 20 ft. above top of rail. The floor depths are given in Table 4.

COSTS

Table 2 gives the estimated costs for the track-elevation bridges. No account is taken of the additional cost chargeable to the concrete structure due to the difference in thickness of floors, nor on the other hand to the additional cost of maintenance of the steel bridges. These amounts, Mr. Bainbridge pointed out, would vary and would tend to offset each other. Paving and sidewalks are figured for an assumed right of way of 100 ft. Rails, ties, ballast and drainage of subways are excluded, as common to all.

Table 3 gives the estimated costs for the street bridges, where the streets are carried over the railroad. The quantities in each structure were given by Mr. Bainbridge, but space does not permit their publication here. The unit prices assumed for the estimate in Tables 2 and 3 are given in Table 5.

ADVANTAGES OF THE DIFFERENT TYPES

Considering the different types of track-elevation bridges, Mr. Bainbridge pointed out that it is desirable to (1) keep the floor of the bridge as thin as possible; (2) avoid any projections above the top of rail which might be a menace to safety, and (3) select a type which can be readily altered to provide for additional tracks. All of the types lend themselves to the first qualification. Bridges of types A, B and C fail in part as to both the second and the third, but D, on account of the short spans, meets them more fully. Types B and D have the objectionable feature of obstructing the center of the roadway.

TABLE 4—FLOOR DEPTHS IN FEET FOR STREET BRIDGES

Type	60-Foot Street		66-Foot Street	
	Steel	Concrete	Steel	Concrete
E2	3	3½	3	3½
E3	4½	5	4½	5
E4	*4	...	*4½	...
	†3	...	†3¼	...
E6	*4	...	*4½	...
	†3	...	†3¼	...
F2	3	3½	3½	3½
F4	3	3½	3½	3½
F6	3	3½	3½	3½

*Without center girder.
†With center girder.

TABLE 5—UNIT PRICES USED IN FOREGOING ESTIMATES

Item	Unit	Price
Excavation for masonry	cubic yard	$1.00
Backfill		
Types A-D		0.25
Types E-F		0.60
Concrete		
Abutments, plain		7.00
Abutments, reinforced		10.00
Pier and column footings		8.00
Columns, type D, concrete		21.00
Columns, types F, concrete		23.00
Floors, steel railroad bridges		18.00
Slabs, type D, concrete		14.00
Slabs, types E, steel		20.00
Floors, types E2 and E3, concrete, and types F		22.00
Waterproofing	square foot	0.20
Structural steel		
Types A-D	pound	0.03
Types E-F	pound	0.03¼
Falsework	linear foot	8.00
Paving, not on bridges	square yard	3.25
Paving on bridges	square yard	2.25
Concrete sidewalk, not on bridges	square foot	0.15
Concrete sidewalk on bridges	square foot	0.40
Hand-rail, steel bridges	linear foot	1.50
Hand-rail, concrete bridges	linear foot	2.25
Engineering and contingencies	per cent	20.0

For street bridges, with the tracks depressed, it is desirable to (1) keep the floors as thin as possible, (2) avoid any obstructions between tracks, and (3) select a type which can be readily altered to provide for additional tracks. Type E lends itself to the first condition, but usually not as well as type F. It fulfils the second but fails in the third. Type F, on the other hand, fulfils the third while failing to some extent in the second.

From an examination of the estimates, stated Mr. Bainbridge, it can be seen that for a two-track or three-track proposition there is little to choose between the cost of bridges for track elevation and those for track depression. Concrete bridges of types D and E are respectively the cheapest types. As the number of tracks increases, however, type F gains the advantage over type E. If the distance between bridges is great this may be more than offset by the extra width of cut due to the wide track centers. In bridges of type E from $20 to $30 per linear foot, aside from the reduced grading, concrete, paving, etc., due to decreasing the floor depth 1 ft., can be saved by using the center girder.

ROUGH COMPARATIVE COSTS for surface, elevated and subway lines were given recently by Prof. George F. Swain in a discussion of rapid-transit problems in cities before the Engineers' Society of Western Pennsylvania. Single-track surface line, exclusive of equipment, costs about $50,000, while the cost of a single-track elevated line, exclusive of equipment, is about $250,000. Suubway costs are so variable that no accurate figures can be given; $1,000,000 per mile for single-track, exclusive of equipment and damages, or $2,000,000 per mile for double-track may, he thinks, be as fair a single figure as can be given. The figure may, however, he points out, be very misleading. The Washington Street subway in Boston, which he thinks is probably the most expensive subway in the world per mile, cost $6,916,000 per mile, including property takings, or $5,103,000 excluding them. For a single exit and entrance stairway in private property $215,000 was paid, and for another entrance to the same station an entire building was bought at a cost of $630,000, and subsequently sold for $587,500.

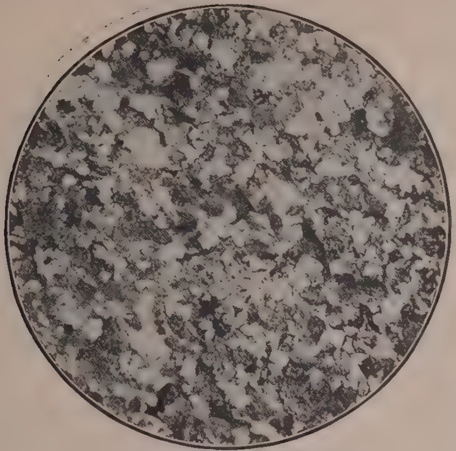


FIG. 3.—SANDSTONE OF QUARTZ GRAINS AND IRON OXIDE CEMENT

Magnification, 50 diameters.

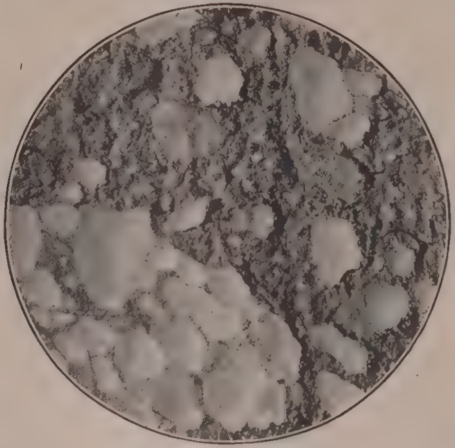


FIG. 4.—CLAY CEMENT SAND GRAIN IN DEFECTIVE CONCRETE

Magnification, 20 diameters.

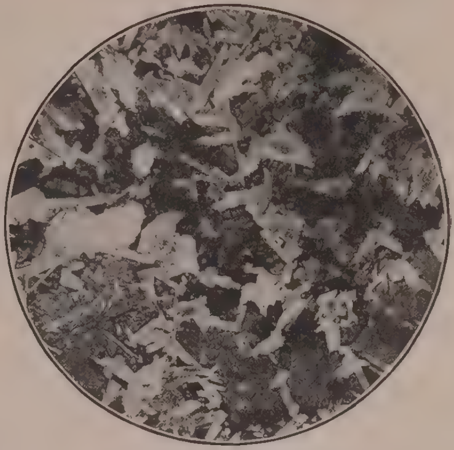


FIG. 5.—TRAP ROCK, SHOWING INTERLACED CRYSTALLINE MINERALS

Magnification, 50 diameters.

Safe Concrete Demands Knowledge of Nature of Sands

Second of a Series of Three Articles Discusses Origin and Structure of Grain and the Value of Tests for Detecting Impurities Which Impair the Strength of the Finished Concrete

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and NATHAN C. JOHNSON, Consulting Concrete Engineer, New York

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IN the preceding article of this series, the value of sand-testing in concrete work was considered specifically from the money-saving side. In this article the necessity for such tests from the standpoint of securing concrete of a definite quality and of preventing loss through failure will be demonstrated. In the third and final article the tests themselves and advantageous methods of securing the benefits desired will be discussed. Any seeming digression from direct results will be occasioned by this sequence of topics.

It is probable that no one factor influencing the quality of concrete is more important than the sand used, both in its character and in its quantity. A moment's consideration must demonstrate that this is true, for not only is about one-third of the total volume of concrete customarily composed of this material, but this one-third volume is made up of millions of small particles or grains, each of which must be thoroughly coated with cement and tied in to its neighbors.

Three Requisites for Sand

In order that these millions of grains may be coherent, a number of qualifications required of them individually and collectively demand attention. First, in order that the cement may properly attach to the grains, each grain must be clean—there must be no coating such as would prevent adherence of the cement. Second, since each of these grains makes up a portion of the mass, each of them, whether large or small, must bear a portion of the total load imposed on the concrete; and to bear this individual burden they must be structurally strong. Third, in order that this load may be distributed among as many grains as possible, so that the load imposed on each shall not be beyond its ability to sustain, and also in order that an undue quantity of cement shall not be required, the grains should be graded in size, so that the medium-sized grains may fill between the large grains, the small grains fill between the medium grains, and the fine grains fill between the small grains. If the grains are all of one size they will lie as would a pile of large cannon balls, with wide spaces between, which would have to be filled with expensive cement. This is but another way of saying that the mass should be as dense as possible.

Danger in Dirty Sand

Since most sands are inert, or chemically inactive so far as their use in concrete is concerned, their value is dependent, not upon their chemical, but upon their physical condition. This physical condition it is sought to determine by sand tests. For instance, it is desired to know if a sand is dirty, since dirtiness may cause the concrete to be an incoherent, crumbly powder. It may be thought that dirtiness should be easy of detection by simple visual means, but often the "dirtiness" on sands is clear, transparent and invisible, the dirt, in such a case, being "matter out of place"—a film of organic matter. Or, if the sand grain is of poor quality, weak, faulty, and unable to sustain its share of load, its condition can be ascertained only by proper tests made not upon one, but upon some tens or hundreds of thousands of grains, which are so chosen by proper means as to be representative of the lot it is proposed to use.

Since, therefore, sands are so important in these several ways to the quality of concrete it will add both to the interest of the subject and to an understanding of their behavior to review their origin and make-up.

Sand, Silt and Clay

All sands are derived from the disintegration and decomposition of natural rock of various kinds. The term "sand" relates to size of grain of this broken-down material, and not to mineral composition, but the prevailing kinds are composed of the harder varieties of rock minerals, since the softer ones tend to break up by weathering, disintegration and decomposition into finer particles, which may be classed either as "silt," or as "clay." To adopt the classification of the U. S. Bureau of Soils, "sand" is composed of such disintegrated-rock particles as have a diameter of from 2 to 0.5 mm.; "silt" is of such particles as have a diameter of from 0.5 to 0.005 mm.; and "clay" such particles as have a diameter of less than 0.005 mm. It is evident that this classification is of importance to the concrete user, for sands are often rejected on the grounds that they contain an undue percentage of either one or the other of these two latter materials. But if these particles are of the same mineral composition and differ only in size why should their presence in sand cause its rejection? The importance of tests in demonstrating this point will be shown in the later course of this paper.

From the earliest ages the formation of sands, silt and clay has been going on through the breaking down of rocks. The changes involved are in part physical and in part chemical. All changes produced at or near the surface by atmospheric agents, which result in more or less complete disintegration and decomposition, are classed under the general term of "weathering." The action of physical agents alone, which results in the rock breaking down into smaller particles without destroying its identity, is termed "disintegration." On the other hand, the action of chemical agents destroys the identity of the minerals by the formation of new compounds, and this latter process is known as "decomposition." Silt and clay generally result from decomposition; and as such chemical change has altered the character of the material, usually to its detriment so far as concrete purposes are concerned, that is one reason, but not the only reason, against their presence in concrete sand.

Agents of Disintegration

Sands, however, result mainly from the physical process of disintegration, so that this process alone will here be considered specifically. The principal physical or mechanical agents involved are (1) temperature changes, (2) mechanical abrasion, and (3) growing organisms. The first agent acts through unequal expansion and contraction of the component minerals and the expansive action of frost, repeated by alternate freezing and thawing. The second agent is one of the most important and acts through the blowing of winds and the flow of waters, concurrently with other agents noted above. The third agent acts through the penetration of roots into fissures, and through the retention of moisture by the plant growth, with promotion of the solvent action of water.

Since sands are of a size to retain and partake of the nature and properties of the parent rock, their structure should be identified with the structures of such rocks; and their strength and fitness for use in concrete may be judged with more or less accuracy from a consideration of the structures and strengths of those rocks known to be suitable for concrete work.

Because of its hardness, resistance to chemical agents and abundance, quartz or silica is the commonest mineral in sand. There are few rocks which do not contain silica in greater or lesser quantities. Other minerals, such as feldspar, mica, etc., because of their lesser resistance, are more readily decomposed by the action of the elements, and by reason of their resultant fine state of subdivision, have been removed by wind and water, so that the quartz crystals remain as the most evident survivors of the parent rock.

CEMENTING MATERIALS IN STONE

A simple and illustrative example of a rock from which quartz sand may be derived is sandstone. This stone is built up almost wholly of quartz grains, cemented together by iron oxide, silica, calcium carbonate, or clay, and on the nature of the cementing material depends the strength and hardness of the stone. The structure of a hard sandstone is shown in Fig. 3. In this stone the cementing material is iron oxide. Under certain conditions of use a fragment of sandstone, such as would be represented by a large sand grain, might be unfit as a material for concrete. Such a condition would be represented by subjecting concrete containing such sand to extremes of heat, as in a fire. Under like conditions it would be expected that a large fragment of the same stone would break up, or "spall," and it is actually found that some sand grains repeat in miniature the behavior of the larger pieces of stone, the disintegration being due to the transformation of the iron oxide cementing material from the ferric to the ferrous state, with increase of volume. Such a condition of heat is, of course, unusual and extreme and would not prejudice the use of such sand for most purposes.

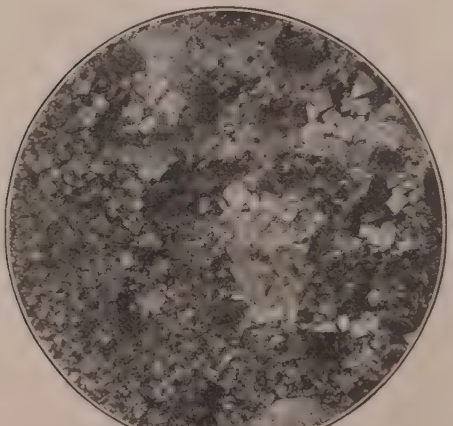


FIG. 6.—MAGNESIAN LIMESTONE, SHOWING COARSE INTERLACED CRYSTALS

Magnification, 50 diameters.

If the cementing material of a sandstone sand grain be calcium carbonate it may be dissolved by natural waters, since such waters contain an appreciable percentage of carbon dioxide, or carbonic acid gas. Such a sand, therefore, would be unsuited for use in a water-storage reservoir, or in drainage tile, or in aqueducts of any kind, or in other constructions which are designed to be impermeable to water. It is not improbable that some structures which show an increasing permeability to water owe their condition to the use of a sand of this character. Fortunately, this calcium carbonate cement in sand is easy of detection by adding a drop of muriatic acid and noting effervescence, or the lack of it.

Clay cement in a sandstone sand is quite undesirable. It is frequently the case that a sand thought to be quite perfect for use in concrete, by reason of its whiteness and good grading in size, is in reality quite dangerous. Clay is not a strong cement, and a sand of which the particles are built up with this cementing material is readily crushed. This is especially true in concrete, for the clay readily absorbs water and becomes a soft paste, leaving the component sand grains loose and without contact with the Portland cement save at the outer surfaces of the outside particles. This, of course, weakens the concrete seriously, if all the sand is of this same general character. An example of such a clay-cemented sand grain is shown in Fig. 4. This sand grain lies in a specimen of an actual concrete which proved faulty in use.

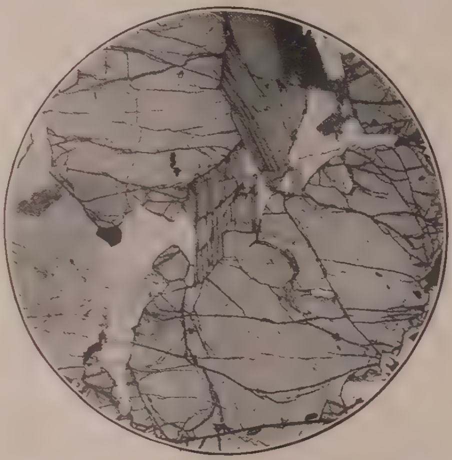


FIG. 7.—GRANITE, SHOWING MICA, QUARTZ AND FELDSPAR

Magnification, 50 diameters.

Trap rock, or diabase, is one of the best aggregates for use in concrete. This rock, as can be seen from Fig. 5, is a heterogeneous arrangement of various crystalline minerals; and it derives its high strength from the strength of its components and their close interlacing. Although highly resistant to weathering, trap rock does disintegrate. It would be difficult in most cases to trace the origin of a sand directly to trap rock, yet it is not improbable that many beds owe a large part of their content to its constituent minerals. Artificial sands made by crushing trap are rarely used because of the difficulty of their manufacture.

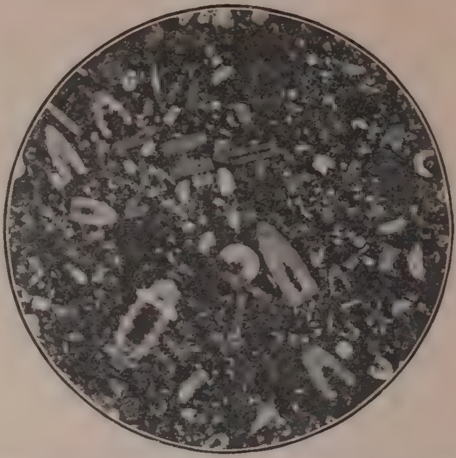


FIG. 8.—FOSSILIFEROUS LIMESTONE, SHOWING LONGITUDINAL AND TRANSVERSE SECTIONS OF CRINOID STEMS

Limestone is another material well liked as concrete aggregate and it, too, derives its strength from the close interlacing of crystals, as can be seen from Fig. 6. Limestone, however, is one of the most soluble of rocks, the extent of solution by natural water, acting in conjunction with other weathering agents, frequently being 99 per cent of the total rock mass affected. Calcic limestones weather more readily than magnesian limestones, and when the latter are of coarsely crystalline texture, as in Fig. 6, the rock weathers through granulation, producing at the base of slopes a heap of dolomitic (magnesian limestone) sand.

Some limestones have mica as an objectionable impurity. This is also a constituent of granites and many sandstones, gneisses and marbles. The use of screenings or of natural sands derived from rocks of this character is to be avoided, for mica in excess of 2 per cent not only weakens concrete by reason of its own low mechanical strength, but its laminated scaly structure further admits and promotes the entrance of percolating and salt-bearing waters into the mass, with oftentimes crystallization of the primary, or of derived salts and consequent disintegration of the concrete. (See Johnson, Engineering Record, Feb. 6, 1915.) A better idea than is perhaps given by a mental picture alone, as to the laminated character of rocks and sands containing mica may be had from a study of the structure of granite, as shown in Fig. 7.

ALL SANDS NOT OF MINERAL ORIGIN

Not all sands, however, are composed of mineral grains, as are those previously mentioned. It is not infrequently the case that the rock from which they came has been formed by the fossilizing, or partial fossilizing, of minute prehistoric shells. A section of limestone, built up in this way, is shown in Fig. 8 (from "Engineering Geology," by Ries and Watson). Other rocks contain like fossil materials, in combination with quartz grains and cementing material, as in fossiliferous sandstone. In many sands derived from such rocks the structure of the shell is so perfectly preserved that the fossils retain their hollow structure and, further, are easily decomposed by agents which either reach them before their incorporation in the concrete, or afterward, by dissolving out the softer portions. The use of such a sand, therefore, is not advisable in concrete which is intended to be impervious to water, or to possess a high strength.

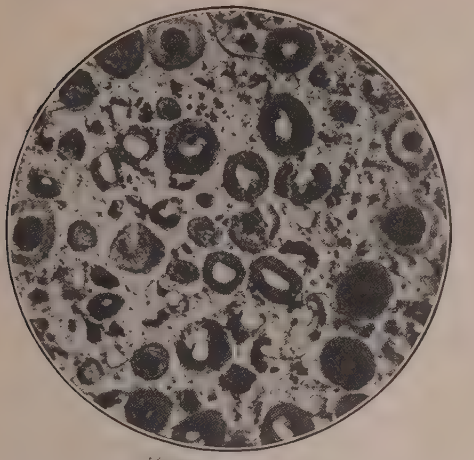


FIG. 9.—FOSSIL-BEARING SANDSTONE, SHOWING FORMATION OF PORES FORMED BY DECOMPOSITION AND SOLUTION OF SHELLS IN FAILED RESERVOIR CONCRETE

Magnification, 20 diameters.

An example of such a concrete, which failed in use, is shown in Fig. 9 at a magnification of 20 diameters. Each of the dark spots in this photograph is a hole, each actual diameter being one-twentieth of the size shown. It is evident that if the section shown in this photograph is typical, percolation must proceed at a constantly increasing rate through the millions of holes thus present initially and constantly augmented in size through the removal of material by solution. The concrete, therefore, must be constantly weakened in an increasing degree through the substitution of hollow spaces for solid material. Further, in situations where the entrant water would hold in solution salts capable of crystallizing, as before noted in the case of mica sands, disintegration of the concrete by this means, as well as disruption by the action of the same water freezing in these pores in cold weather, is extensively aided.

CARBONACEOUS IMPURITIES

Sands containing carbonaceous matter, such as coal, should also be subject to rigid examination. Such impurities generally carry with them a greater or less percentage of sulphur which, by decomposition and oxidation in the presence of water, may have a direct disintegrating action on the cement of concrete. In addition, the carbonaceous matters are structurally weak, so that the strength value of the concrete composed of them is considerably lowered. It is not infrequent to find such adulterants in sands lying in and along rivers tributary to coal-bearing regions, but their detection is usually easy by visual means.

In this particular study of sands the central thought has been to demonstrate the very real necessity for the testing of sands on the ground that their properties, structurally, must control the quality of the concrete produced. What has been said in regard to sand applies equally to the large aggregate—the stone. It is held, however, that of the two materials, it is more important to test the sand, for sand is a loose, incoherent material which it is sought to consolidate by mixing with cement, while each of the stones is a naturally consolidated dense material, the pieces of which are far less in number than the particles of sand—for even a small piece of the large aggregate would contain in ideal relation and compactness many thousands of the particles of sand. Further, and of almost paramount importance, by its very looseness and incoherency, and also by the extensive surface presented by the total of the individual surfaces of all of the millions of sand particles in a cubic yard, it is evident that sand is capable of retaining upon and between its individual grains appreciable quantities of various impurities, which may have a most pronounced effect upon the quality of concrete. Contrasted with sand the retention of like impurities by the large aggregate, both because of its relatively small surface and because of the manner of its production, is almost negligible.

ORGANIC IMPURITIES

It must be evident from what has been said as to the manner of the formation of sands, by the surface weathering of rocks, that rarely, if ever, are the sand deposits from which material for concrete is obtained on the site of the original rock. From the nature of the deposit, usually in deep stratified layers, it is evident that some agent has transported them from their original site to the place where they are found. Wind action may have played a part, but the more important action, particularly from the standpoint of contained impurities in the sand, was that of ancient streams and glaciers. Indeed, it is quite possible to trace in some deposits the form of the wave which lapped the prehistoric shore as in Fig. 10. Since this is so, and since the water which took the sand grains from the rock site where they first were formed must also have carried with it other materials as well, many of which were undoubtedly of an organic origin, it is reasonable to look for traces of such organic substances in the sand deposit. Further, and also more probably the direct cause of their presence, since the passage of the ages would in all likelihood have decomposed the original substances, the percolation through the sand of ground and surface waters holding like substances in suspension or solution, with deposition of films, such as of tannic acid, around the grains, is to be expected in some localities, for sand is especially adapted to encourage such percolation, and water takes the path of least resistance.

Special stress is laid on this particular impurity of sands, since it is one of the most obscure and ordinarily the most difficult of detection. Further, it is one of the most pernicious in effect, for a sand which may seem as clean and as white as might be desired, may contain a sufficient amount of such an impurity as to prevent the setting of the cement. Cases, such as this is, are of not infrequent occurrence. The exact chemical reactions with the cement are not known, but enough is known of their effect to make guarding against them of the utmost importance. It is unpleasant, to say the least, for a contractor to use, in all good faith, a sand of this kind in considerable quantities before discovering that the concrete will not harden. It is also quite likely, unless tests are previously made, that before the impurity is detected he will have contracted for large quantities of this same sand, so that considerable financial loss will be occasioned both directly and indirectly. Nor can fault be found with the inspector for rejecting the sand and the work, for even if the concrete sets up at all, it would be manifestly unsafe to subject the structure to strain.

The right and safe course to pursue is to insure at the outset that the sand is of proper quality, free from such impurities, and to guard against their introduction during the course of the work. Nor is this later introduction an impossibility. The hauling of sand in manure-wagons, with the retention of small quantities of manure, has happened more than once. The use of water contaminated by animal refuse or urine, or stable or barn-yard drainage may be equally productive of bad results. These latter are in the province of field precautions rather than of the testing of sands with which this article particularly deals. They are, however, related to the testing for organic impurities as illustrations of like actions on the concrete. (See also J. R. Freeman, Engineering News, July, 1912.)

It is evident, therefore, that all sand is not good sand, fitted for general use in all concrete, any more than shale can be used where granite is required, or that granite be used where shale is desirable. Sand is not necessarily a simple, hard substance, of immeasurable and certain endurance, but on the contrary, is frequently a composite arrangement of various substances which may or may not be enduring, according to the use in which they are to be employed. The desire of every contractor should be to give as good a product as the price he receives will permit, and the question of substituting a sand of suitable characteristics for one more cheaply obtainable must, under many cases of competitive bidding, force him to forget quality in favor of cost. This explanation as to the behavior of sands is not, therefore, addressed solely to the contractor, but to the owner, architect and engineer who ask for bids. If they desire to subordinate advantages of permanence to some slight saving in first cost, the contractor is almost helpless, but it is believed that before long—a time proportionately short as knowledge in regard to concrete and the factors affecting it becomes accurate and general—there will be a change in viewpoint, such that *proper quality* will be a first and foremost consideration.

The primary function of sand tests is to render possible good concrete. First cost should be a secondary consideration. The possibility of making large savings in cost of materials is most frequent in those cases in which the contractor has available a variety of materials at varying prices and of different qualities. In such instances it is possible by means of properly conducted tests to choose a sand, or combination of sands, at low price, which will

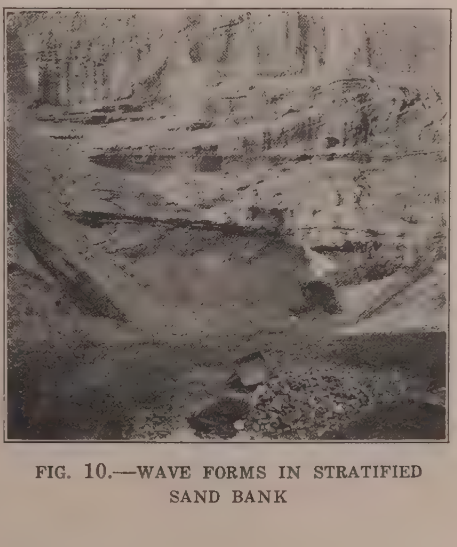


FIG. 10.—WAVE FORMS IN STRATIFIED SAND BANK

give superior results. It may happen, however, that tests will show that the sand which is cheapest is of such poor quality as to prohibit its use, either alone or in combination. But even though such tests may result in the condemnation of the cheaper material, they will insure a better quality of finished product, which, after all, is the real object of all tests of materials of engineering.

"SHARP" SAND NO QUALITY GUARANTEE

A word should here be said in regard to the requirement of many specifications that sand shall be "sharp." It is difficult to trace the origin, or to define the exact meaning of this word. If it means that the grains shall be angular it is evident from what has been said in regard to the action of water in transporting sand, with the inevitable attrition attendant, that all natural sands must be more or less rounded of grain. It was perhaps the idea originally that angularity would result in closer compacting of grains, or that a greater number of facets would be presented for the adherence of cement. It has, however, time and again been proved that angularity of grain is no advantage and that rounded grains make as strong, if not a stronger mortar or concrete than do angular grains. It is also significant as to the value of this point that no two persons, even those who lay stress upon it, are agreed as to the meaning of the term "sharp," yet in spite of all that has been written and said on the subject the requirement constantly recurs and is as dear to the heart of the specification-writer as are Latin labels, survivals of the ancient times, to the druggist of today. A requirement which is without positive benefit, which is unenforcible, which is capable of many interpretations and which may work hardship, or injury, or both, is better omitted.

If, however, the original idea were to produce a more dense concrete through the closer compacting of angular grains, the idea was of value, even though premised upon incorrect assumptions. The importance of grading sand grains, so that the smaller sizes shall progressively fill the spaces between the larger, cannot be exaggerated. The ideal aimed at in making concrete is to produce a substance approximating the density and strength of natural stone, which, as has been seen from the structure-photographs presented in this paper, is natural concrete. But in the formation of this natural concrete forces such as pressure (in sandstones and the like) and crystallizations (as in limestone and trap rock) and fusion (as in granites and trap rock) not available in the making of artificial concretes, have aided in the consolidation. The only means at hand in concrete as made by man is to so grade the materials as to form as dense a mass as possible.

BEST CRITERION DENSITY OF MIX

One criterion, although not an absolute standard, of such grading, already referred to, is Fuller's curve, and this is known to give good results. It has also been stated that filling the inter-grain spaces by smaller grains of cheap, strong, inert material would cut down the amount of cement necessary to be used. This has a further advantage in that it makes possible the thinning of the cement layers to a degree greater than would be the case with an ungraded material, with resultant increase in strength, since cement is inherently weaker and more uncertain in structure than the usual aggregate. These points will be enlarged upon somewhat in the third paper of this series.

But in thus grading the fine aggregate there is a limit of subdivision which should not be exceeded. Silt and clay have been stated to be materials of like mineral origin with sand, but varying in degrees of fineness. It is evident from a moment's consideration that if the grading is carried down to a point such as to include particles of a fineness equal to that of these materials the size of the cement particles themselves will be approximated by these inert materials, so that there will necessarily be considerable difficulty in properly coating each of these fine grains with the cement, since the reaction of cement and water is a slow process, not producing a covering paste, or glue, except after a considerable interval of time. There is also an added difficulty involved in their use, in that these very fine, inert materials, when wetted, tend to bind closely together, thus preventing the access of cement to them, so that in one way and another they form an uncemented nodule in the concrete with consequent detriment. And last, but not least, it is especially difficult to be sure that such fine materials are not contaminated by organic matter. It is this contamination which is meant by the term "loam," and its dangers to concrete have been set forth in the discussion on the effects of organic matter. For all of these reasons, therefore, the presence of silt or clay in concrete is to be regarded at least with suspicion.

It is believed that from the foregoing, the propriety and constructional value of testing sands for use in concrete will be granted by all. The means of deriving benefit from such tests is perhaps not so evident. The first difficulty that presents itself is the nature and performance of the necessary tests. The second is the interpretation of the results when obtained. The third is their utilization. These matters will be treated at length and suggestions made for advanced yet simple procedure in the next article of the series.

Some Actual Railroad Contingencies and What They Cost

IN SUPPORT of the railroads' contention at the recent valuation conference in Washington that a liberal allowance should be made for contingencies, E. Holbrook, special engineer on valuation for the Union Pacific and Southern Pacific systems, gave some actual instances where unforeseeable circumstances had made actual costs far exceed the estimates. A bridge estimated to cost $21,000 did cost $32,000, because a flood washed out a bulkhead protecting some of the masonry. A pipe line estimated at $6600 cost $8300, because delays put the completion of the work over into the winter. Because of a bad slide a change of grade cost $12,000 instead of $7100. Storms and washouts ran the cost of a railroad yard up from the estimate of $41,500 to an actual figure of $66,700. Excessive water made a tunnel cost $23,000 instead of the $16,700 anticipated. In terms of the total estimated costs these excesses were respectively 52, 26, 69, 61 and 38 per cent.

To get further light on the subject of contingencies Mr. Holbrook had an estimate made of the cost of the Lucin cutoff of the Southern Pacific Company across Great Salt Lake, the engineers making the estimate having full advantage of all facts visible at the site. When the estimate was totaled, Mr. Holbrook stated, it would have been necessary to add 33 1/3 per cent for contingencies to bring the figure up to the actual cost.

Grub Hoes Clear Seattle Gutters

FOR the first time in his official experience, Charles R. Case, superintendent of streets of Seattle, has directed the use of grub hoes to clean a down-town business street. Merchants on Second Avenue, between Madison and Seneca, where creosoted wood-block paving was laid a year ago, insisted that the street be given more attention than the ordinary water treatment, which would not move the accumulation of pitch and creosote which filled both gutters.

PITCH ACCUMULATION IN SEATTLE GUTTERS REMOVED BY GRUB HOES

PRESENT-DAY CONCENTRATION OF BUSINESS in a small area, stated Prof. George F. Swain recently to the Engineers' Society of Western Pennsylvania in discussing rapid-transit problems in cities, is due to three engineering developments of the last few years, namely, the skyscraper, the elevator and the telephone. While the development of steel-frame construction for high buildings is what has made concentration of business possible, skyscrapers themselves, he pointed out, would not be practicable without the elevator and the telephone. He cited an investigation made a few years ago by the American Telephone Company as to the relation of the telephone to one of the skyscrapers in New York City. It was found that if all the messages transmitted by telephone to and from the building had to be carried by messengers the entire area of the building would be required for elevators.

Floods Top Unfinished Dam—Green Concrete Uninjured

Work Three Days Old on California Structure Survives Floods Which Submerge Crest Under 5½ Feet of Water

By CYRIL WIGMORE
Construction Engineer, Crags Land Company, Los Angeles

A SMALL concrete dam recently built near Los Angeles, Cal., was about four-fifths completed when heavy rains caused a flood stage in the stream, which drove the construction gang from the work and submerged the green concrete on the dam to a depth of 5½ ft. After the high water subsided, the dam was found to be intact, forms were restored, and the structure was completed and accepted.

The work was begun in December, 1912, when the writer was called upon to supervise the design and construction of a concrete dam to be built for the Crags Land Company, of Los Angeles, Cal. The site selected was on Triunfo Creek, about 5 miles from Calabasas, Los Angeles County, where a dam 50 ft. high would form an artificial lake and reservoir a mile long, with a capacity of approximately 400 acre-ft. The original design was a gravity section, but after inspection of the site it developed that the location was suitable for an arch dam and that money could be saved by adopting this type of construction.

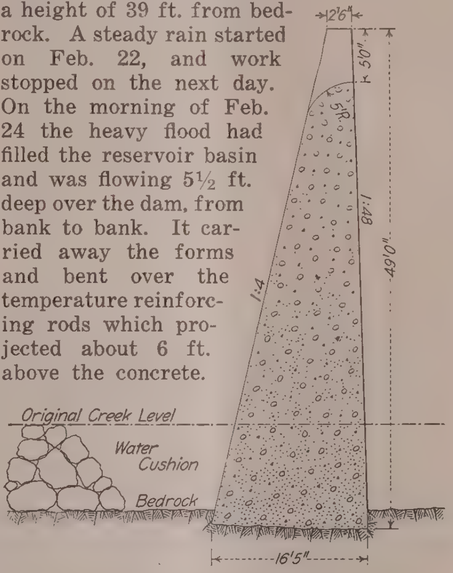
DESIGN DETAILS

The design finally approved provides for a simple arch structure with a radius of 287.9 ft. and a total length on top of 149 ft. The spillway is 100 ft. in length, with parapets on either end 5 ft. higher than the spillway crest, and pilasters spaced 12½ ft. apart in the spillway for the purpose of carrying a removable plank walk across the dam. The maximum height from bedrock to spillway is 46 ft., the top width of the parapet wall is 2½ ft., the batter of the upstream face is 48 on 1 and the batter of the downstream face is 4 on 1, making the average thickness at the base 16 ft. On the upstream face ⅞-in. reinforcing bars were used for temperature stress only.

Good sand and gravel were at hand in the reservoir basin and the proportion of concrete determined upon was 1:3:6, with a 6-in. facing on the upper and lower faces of 1:2:4. Plums, consisting of washed boulders from the creek bed, were used up to 25 per cent of the volume until the spillway height was reached. Bedrock and side walls, which were of hard, igneous rock, were blasted to a depth of 2 ft. and test holes were drilled to a depth of 8 to 10 ft. farther showing sound rock all the way.

FLOOD FILLS RESERVOIR

Concreting was started in January, 1913, and continued until Feb. 23, and at this time the dam had reached a height of 39 ft. from bedrock. A steady rain started on Feb. 22, and work stopped on the next day. On the morning of Feb. 24 the heavy flood had filled the reservoir basin and was flowing 5½ ft. deep over the dam, from bank to bank. It carried away the forms and bent over the temperature reinforcing rods which projected about 6 ft. above the concrete.



THE DAM IS ARCHED IN PLAN

After the water had subsided, however, it was found that not more than 2 in. of concrete was washed off the top of the dam and even that immediately surrounding the rods where they had been bent down was not disturbed for a depth of more than 6 in. At this time the oldest concrete in the dam had been in place only seven weeks, and the upper 4 ft. was not more than three days old.

Three days later, after the flood had subsided, work was resumed and the dam was completed in March, 1913. The bottom sluice was then closed and since that time the reservoir has remained full. In 1914 three successive floods passed over the dam, the maximum height recorded over the spillway being 10½ ft., or 5½ ft. over the parapet walls.

WATER SUBMERGES DAM CREST 5½ FEET AS FLOOD RECEDES AFTER CARRYING AWAY FOOTBRIDGE BETWEEN PARAPETS

Reject Untried Sewage Treatment Methods for Decatur

Langdon Pearse and S. A. Greeley Characterize Activated Sludge Process as Yet Too Sensitive for Dependable Operation

REFINEMENTS of sewage treatment in the next ten years will probably be secured largely by the most careful operation under skilled specialists, according to a report on the sewerage problem in Decatur, Ill., by Langdon Pearse and S. A. Greeley. This statement was made in the discussion of the possibilities of new processes and in the conclusions that there is no valid reason at the present time to advise delay in the program because of immediate or future developments in the art of disposal. Further comment is as follows: The principles of treatment are well established and the method of execution definite. What the city requires is a substantial working plant of demonstrated efficiency beyond the zone of experiment, with sufficient flexibility to operate with a minimum of efficiency.

NEWER PROCESSES CHARACTERIZED

Electrolytic processes are unsatisfactory at present and of uncertain value, being essentially producers of chemical reactions which can be carried out better and more cheaply in other ways. Their chief claim is sterilization, which is accomplished far more cheaply by the use of chloride of lime. Of the other processes "activated" sludge is the newest as well as the most experimental and untried.

For Decatur conditions an ideal plant for the domestic sewage consists of coarse screens, a grit chamber, settling tanks of the double-deck or Imhoff type, sprinkling filters, secondary settling basins and sludge drying beds. A certain flexibility of control is desirable, which is obtained by the use of several units. For the handling of storm flows auxiliary storm-water settling basins may be helpful.

The removal of coarse material by bar screens, followed by the deposition of detritus in grit chambers, the settling of suspended matter and the digestion of the sludge in double-deck tanks, the oxidation of the settled liquid in sprinkling filters are all processes of definite tried value, and the apparatus now available for such purposes has a distinct economy of design which will be increased but slowly.

The estimated annual cost as of 1930 for 59,340 people is $32,722. This includes an operating force with a chemist at half time, the other half of the time to be charged to the operation of the water filtration plant. Besides supplies and ordinary repairs, the engineers estimated on depreciation and renewals, and allowed interest on the investment at 5 per cent. The total cost is $421,600, the main items included being double-deck settling tanks, $99,600; 4 acres sprinkling filters, $216,000; double-deck secondary basins, $40,000, and storm-water tanks, $20,000.

ACTIVATED SLUDGE CONSIDERATION

The advantages claimed for the activated sludge processes are freedom from odors, economy of ground space and production of a sludge higher in nitrogen than the usual domestic sludge. On the other hand, the process at the present stage apparently has serious disadvantages—more costly tanks, constant need of adequate aeration, delicacy of control which may be easily upset by conditions beyond the control of the operator, and lack of application to continuous operation. The possibility of sale of the sludge is dependent on values which probably cannot be maintained in actual practice, particularly for a small plant in competition with large plants. Very little data exist on the actual nitrogen content to be expected.

On the basis of 2 cu. ft. of air per gallon of sewage treated a plant embodying the activated principle was estimated to cost $360,000, and on the basis of 1 cu. ft., $262,000. The respective annual costs were $73,338 and $58,648, and the air compressors and power equipment were estimated at $55,890 and $41,200.

Wash Borings Aid in Railroad Valuation Work

By Their Means the Amount of Settlement of Fills on Soft Ground Was Found, and Shown to Be Surprisingly Large

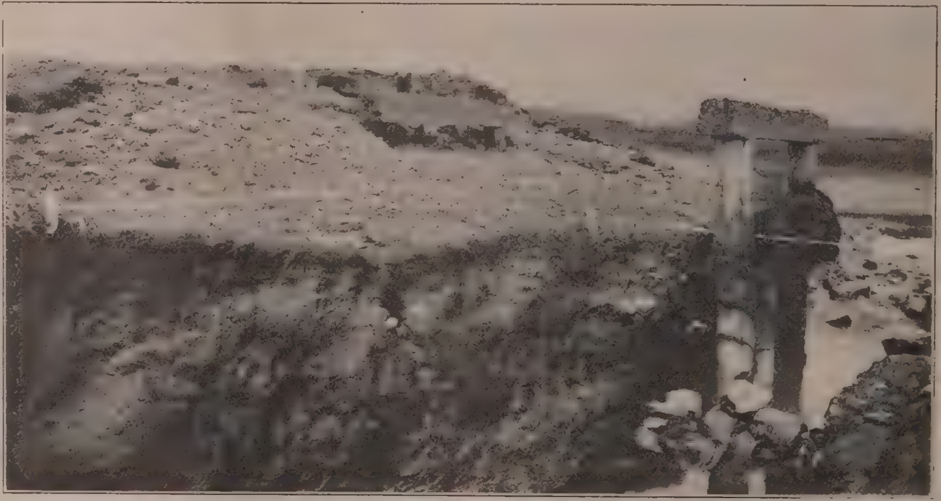
THE AMOUNT of settlement of railroad embankments into swampy or soft ground is one of the hidden items difficult to ascertain in cross-sectioning these embankments for valuation purposes. Often the visible embankment is only a small part of the material actually placed. A considerable part of the mileage of the Boston & Maine Railroad along the sea coast consists of fills made on soft marsh ground, and in many inland places there are fills made in fresh-water bogs or swamps. The valuation department of the road knew that there must have been settlement in these places, although careful observation on the ground gave no such indication. The department, therefore, concluded to make some wash-boring tests to see if the line of demarcation between the sand, gravel or dirt fills and the original peat or swamp material could be determined. The result was that with an expenditure of approximately $3400 about 850,000 cu. yd. of material in excess of that shown by the cross-sections made by the Government was discovered. Notes from a report on the subject by F. C. Shepherd, valuation engineer of the Boston & Maine, were presented by P. E. Thian, valuation engineer of the Northern Pacific Railway, in a paper recently read before the Northwestern Association of members of the American Society of Civil Engineers, at Minneapolis. These notes, in turn, are taken from Mr. Thian's paper.

THE BORING OUTFIT

In making the test arrangements were made with a local contractor to make wash borings along these fills, this contractor having outfits which he used especially for making test borings and having men whom he employed for this kind of work only, and work which he had been doing in the locality for a great many years.

In using the wash-boring machine a 2-in. casing was first driven by means of a special hammer and then the material inside was washed out by using a smaller pipe with force pumps. It was found that with this machine the elevation of the top of the peat or marsh material could be determined, and that the results showed a large amount of settlement below the original surface of the ground as located by the Government cross-sections on either side of the fills. It was therefore decided to make borings wherever there were such fills. At the same time the attention of the Government engineers was called to the matter, and they made careful study of the results.

When the borings were first started the question was raised by the Government representatives as to whether in driving the casing the gravel and sand were not forced down into the peat, resulting in a lower indicated depth for the top of the peat than was the actual condition. To test this, at the same place where the first two wash borings were made the contractor dug pits in the open. This was done by a patent method used by the contractor in putting in foundations for buildings, and by means of steel cylinders, which left one inside the other, the largest being 42 in. in diameter and 4 ft. long, it was possible to sink test holes to the peat line, and the material in these cylinders showed that the results obtained by the wash borings were within an inch of actual conditions. It was then agreed by the Government engineers that the work of the wash-boring machine would be accepted, and they accordingly placed an inspector on the work.



THIS CUT THROUGH AN OLD FILL SHOWS THAT ORDINARY CROSS-SECTIONS MAY FALL FAR SHORT OF RECORDING ACTUAL QUANTITIES IN SOFT GROUND

As it was necessary to carry on this work without interference to traffic, the borings were taken at the shoulder of the fill, and it was arranged with the Government engineers that these borings would be taken not more than 1000 ft. apart on alternate sides of the track, the distance depending on the length of fills and any intervening conditions.

SHAPE OF THE FILL SECTION

To establish the line of the bottom of the fill, or the top of the peat material as it existed, four borings were made at one point across the roadbed, one at either shoulder and one halfway down the slope. The result of this indicated that the bottom of the fill at the two shoulder points was approximately level and from this point out the line rose. At the same time further proof of this was obtained at a near-by point on one of the abandoned lines where the State had recently cut through part of the old roadbed for some other work. These also showed that the line of the bottom of the fill was practically level from shoulder to shoulder, running up from the shoulder point to the ground surface at the toe of the slope. It was therefore arranged with the Government representatives that after taking borings at the shoulder they would show on their cross-sections the extra material as being level from shoulder point to shoulder point and then running up to meet the toe of the slope as determined on the ground.

During the season there were two machines on this work, and at an expense of approximately $3400, which included the use of the machines, the flagman, and the company's engineer, about 850,000 cu. yd. of material in excess of that shown by the cross-sections made by the Government was located.

It was also found that the machine was particularly valuable in a number of freight yards where the wide area was practically on fill. By the use of the machine in these yards it was possible to find irregularities of the original ground surface, and in one instance more than 60,000 cu. yd. in one mile were found in excess of what would have been indicated in any other way.

Supplementing the foregoing, the accompanying photograph, and information relating thereto were obtained from Mr. Shepherd. As further proof of the amount of settlement of some of the embankments ditches were dug entirely through some of the fills and carried down below the original ground surface. The illustration shows an actual section cut through one of the company's abandoned roadbeds built some years ago on a salt marsh location. The road was originally carried on a trestle and subsequently filled in. The upper string stretched across shows the approximate original line of the ground, while the lower one indicates the amount of settlement in the middle. The view also shows the slopes where the settlement runs up to meet the original surface.

THE YARDAGE RECORD FOR CONCRETE PAVEMENT laid by a city during 1914 is claimed by Kansas City, Mo. According to "Concrete Roads," the Universal Portland Cement Company's publication, that city built 365,323 yd. of this type of pavement last year.

Refuse Incinerator Guarantees Are Too Strict for Practical Fulfilment

Liberal Interpretation of Specifications Necessary for Acceptance of Plants Under Prevailing Contract Terms—The San Francisco and Atlanta Cases

By A Special Contributor

THE DECISION of city officials in Atlanta, Ga., and San Francisco, Cal., to reject high-temperature refuse incinerators, because of the failure of the plants to fulfil certain guarantees under test, has brought the character of the specifications into question. High-temperature refuse incineration is a comparatively recent development in this country. The first plants were built at Westmount and Vancouver in Canada, and at West New Brighton, N. Y., and Seattle, Wash., in this country—all of which were constructed between the years 1905 and 1908.

These plants were all patterned after English design, and, in fact, were built indirectly through English concerns. A larger plant, with a capacity of 300 tons per day, was completed for the city of Milwaukee in 1910. Since that time, no less than eight of these plants have been built in this country, with capacities ranging from 50 to 250 tons per 24 hours. In this comparatively short time, rapid progress has been made in the design of the plants, particularly as relates to the mechanical handling of the refuse to be burned, and the clinker resulting from the combustion. All of the plants of this type in this country, however, are similar in the general principles of design, construction and operation.

SPECIFIC GUARANTEES REQUIRED

The first four plants built were let under lump-sum contracts without special guarantees of operation or steam production, and the bids were compared on the first cost of the plants. The first specifications, typical of those now in general use for high-temperature incinerators, were used at West New Brighton in 1907 and at Milwaukee in 1909. The Milwaukee specifications left the design of the details of the plant to each bidder, protecting the city by requiring guarantees of operation along certain definite lines, very much as the performance of pumping engines is guaranteed.

The specific guarantees required may be summarized as follows: (a) That no nuisance be created during the ordinary operation of the plant; (b) that no odors, obnoxious gases, smoke or dust escape from the chimney; (c) that the temperature of combustion shall not fall below 1250 deg. Fahr.; (d) that the residuum from the furnaces be thoroughly burned, hard and free from organic matter; (e) that the rate of combustion meet the statement guaranteed in the bid; (f) that the rate of evaporation in the boilers be not less than was stated in the bid, and (g) that the labor cost per ton be not more than was stated in the bid.

These guarantees have since been included in practically all specifications for high-temperature refuse incinerators. Certain modifications of expression have been used for each locality, but the essential features of the guarantees have remained the same. Specifications recently issued at Toronto, however, for a plant to have a capacity of 160 tons per day, include several important modifications, to be mentioned later.

DISPUTE AT SAN FRANCISCO

When the fulfilment of contracts and specifications becomes the subject of litigation, weak points, if there be any, are likely to appear. The city officials in Atlanta and San Francisco have refused to accept the incinerators built for their cities, claiming that certain of the guarantees have not been fulfilled. The case at Atlanta is now before the court for its second trial, and testimony has been taken. The San Francisco case has not yet come to trial. It is pertinent to inquire into the relation between the specifications and guarantees, the failure of the plants to pass the tests, and general local conditions affecting the situation.

The plant at San Francisco was tested by the city officials as required by the specifications, for a period of 30 days, from Sept. 4 to Oct. 3, 1914. The results of the tests were reported by the city engineer with the recommendation that the plant be rejected for the reason that it did not fully meet the requirements of the specifications. The guarantees were essentially those quoted above from the Milwaukee specifications. The city engineer held that the plant failed to meet the requirements in the following particulars: (1) That no nuisance be created in its normal operation; (2) that no olors, obnoxious gases, smoke or dust escape from the building or the chimney; (3) that the temperature shall at no time fall below 1250 deg. Fahr. (this guarantee, however, was fulfilled in that the average temperature was in excess of 1500 deg. Fahr.); (4) that the residue from the furnaces be thoroughly burned, hard, and free from organic matter. In all other requirements the guarantees in the contractor's bid were fully met.

ATLANTA PLANT REJECTED

The grounds on which the city officials at Atlanta refused to accept the plant are very similar to those at San Francisco. It is claimed that nuisances are created during the operation of the plant; that dust, smoke and odors escape from the buildings; and that the residuum from the furnaces is not free from organic matter. It was also claimed by the city officials that the plant could not make steam at the guaranteed rate. This point hinged on whether or not the work done in the feed-water heater could be credited to the plant. The actual rate of evaporation under test fell either above or below the guaranteed rate, depending upon whether or not the evaporation was computed from hot or cold feed-water. The plant was tested on two occasions for periods of about one day each.

In both San Francisco and Atlanta the plants were operated by the contractor during a tuning-up period of about one year prior to their being tested. Defects in design and construction, which appeared during this time, were in each case remedied by the contractor, and it appears that so far as design and construction are concerned the two plants are up to the best work that has been done in this country and abroad.

GUARANTEES UNWORKABLE

From this brief summary of the development and character of specifications now used for the construction of refuse incinerators, and from the statement made of the reasons for the rejection of plants of this type by two comparatively large cities, several deductions can be made. In the first place, the guarantees relating to the sanitary operation of the plant are so stated that their fulfilment is virtually impossible. It is a matter of great difficulty to handle mixed refuse so that absolutely no nuisance is created, and it is also practically impossible to prevent absolutely the escape of all obnoxious gases, smoke or dust from the chimney or building.

In other tests of incinerator operation under guarantees, engineers have interpreted these requirements somewhat more liberally. Plants which have fulfilled the intent of the guarantees have been accepted by city officials upon the recommendations of their engineers. In some instances, the recommendations have been qualified, as at Milwaukee, where it was stated that "a certain amount of dust and hot gas must be created, and it is, of course, not feasible to confine all of this inside the furnaces and ventilating ducts."

The requirement that the residuum from the furnaces shall be free from organic matter is also difficult to fulfil. In most instances where cities have accepted proposals in which this guaranty is made, there has also been required from the contractor a statement showing the method of computing the heat balance. Such heat balances include among the losses, an item for unburned carbon in the clinker and ash. Obviously this statement, presumably accepted by the city with the proposal, is in conflict with the requirement that the residual material be free from organic matter. It is evident, therefore, that in plants which have been accepted as having fulfilled this guaranty, the interpretation of the test has been liberal.

TORONTO SPECIFICATIONS

The Toronto specifications on these points include the following guarantees: (1) That no smoke shall at any time escape from the chimney of a degree of darkness or density greater than that determined by density 1 of Ringelmann's smoke chart; (2) that no dust shall be emitted from the top of the chimney; and (3) that the residuum from the furnaces shall not contain more than 1 per cent of organic matter, exclusive of carbon.

It is quite possible to build plants which will fulfil these guarantees. Contractors who undertook to build plants under the stricter guarantees must have counted upon a liberal interpretation by city officials. It is probable that the definite statements of these guarantees were forced into the specifications by public opinion. The attempt of one side in a garbage controversy to satisfy the opposition may have led to promises incapable of fulfilment.

CATCHBASINS IN DECATUR, ILLINOIS, are all cleaned once a year and some of them three times a year.

HEAD HOUSE IS FLANKED AT EITHER END BY A MASSIVE OCTAGONAL TOWER

Longest Municipal Pier in United States Is Nearing Completion at Chicago

Structure, 3000 by 290 Feet, Provides Separate Passenger and Freight Facilities with 660-Foot Recreation Building at Outer End

BY NEXT FALL Chicago will possess the longest municipal pier in this country. It will be devoted to freight and passenger traffic and recreation. The head house and the freight and passenger buildings are nearly completed and the contract has recently been let for the recreation building. The pier is located 700 ft. north of the Chicago River and is No. 2 in the comprehensive outer-harbor plan which Chicago has under way to rehabilitate its fast disappearing lake traffic.

The pier proper is 3000 ft. long and 292 ft. wide and has for an approach a plaza of approximately 21 acres which were reclaimed from the lake and will be used in the future for commercial purposes in connection with further developments of the comprehensive harbor. The head house is immediately west of the freight sheds, while the extreme easterly, or lakeward, 660 ft. of the pier is devoted exclusively to recreation purposes, this being the first application of the recreation-pier idea in Chicago.

SUBSTRUCTURE

The dock walls consist of three rows of round piles from 50 to 60 ft. long with the outside row supporting Wakefield sheeting. The space between the rows of piles is filled with stone to about 1 ft. below datum (this being approximately the water surface), and on top of this stone fill is built the concrete cap to El. 6.5. The area 256 ft. wide between the dock walls is filled with earth, the greater part of which was deposited by means of an hydraulic dredge working from 200 to 700 ft. from the pier. A large part of the stone was obtained from the spoil banks of the Chicago Drainage Canal and was brought by barges to the site in boxes of 3½-yd. capacity.

The construction of the docks is typical of the Chicago district except that the 12 x 15-in. sheet piling is heavier than used elsewhere, and that the tie rods, or anchorage, were placed 2½ ft. below the water surface. Reinforced-concrete mud sills, 9 x 9 in. in cross-section, were used in place of the usual timber sill. The two outside rows of piles are spaced on 4-ft. centers, while the back row is spaced on 2-ft. centers. Anchor piles in the approach were driven on 8-ft. centers, 30 ft. from the back row.

The inside row was carried ahead of the other two rows while another pile driver carried along the center and outside rows. The anchor rods for the center and back rows were set at their proper position, after which the front row of piles was lined up and held with temporary anchors. As soon as the sheet piling was driven the permanent anchors were set and the space between the piles filled with stone.

The concrete cap was poured in place in alternate blocks 30 ft. long. All the material was brought to the work on scows and mixed in a floating tower equipment. The amount of concrete placed depended a great deal on the condition of the lake, a slight swell cutting down the yardage per day materially. On calm days as much as 420 cu. yd., or 120 lin. ft. of the dock, were placed with one mixer.

As it was contemplated to rush the entire work to completion in the shortest space of time possible, the commission decided to carry the superstructure entirely independent of the earth fill, hence pile foundations were designed for all the buildings. It is believed that all known records for speed were broken on this construction, as more than 17,000 piles were driven, 1¼ mi. of concrete dock were constructed and upward of 1,000,000 cu. yd. of earth fill were placed in a period of nine months.

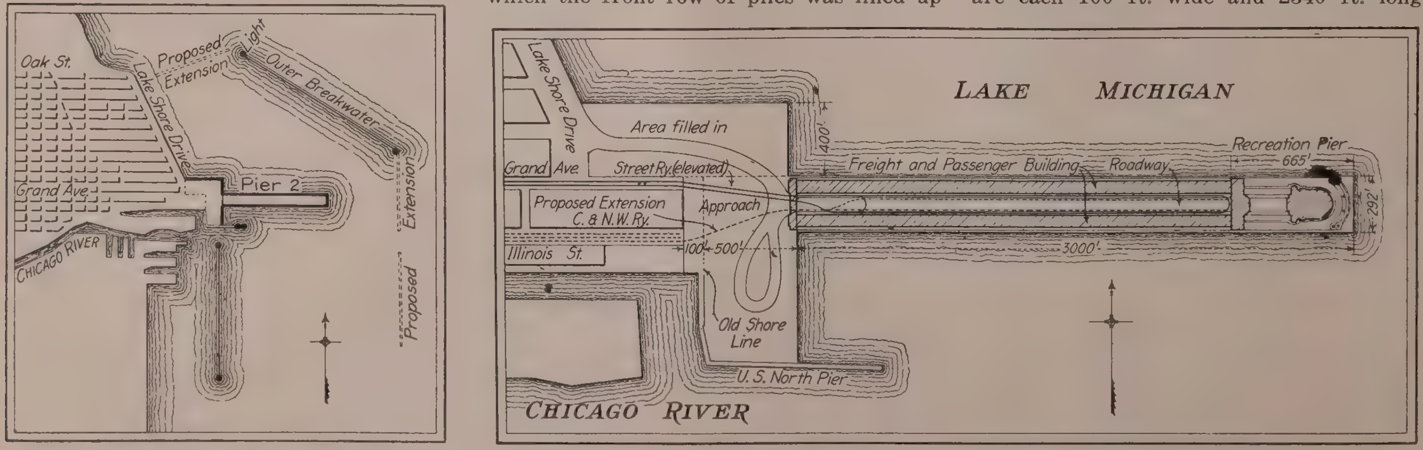
WATER TANKS IN HEAD HOUSE

The head house facing the plaza is a steel structure faced with brick, stone and terra cotta, with an ornamental tower near each end. These towers each contain a 60,000-gal. steel tank to supply the sprinkler system in the freight sheds.

As noted in one of the drawings, the 80-ft. roadway passes between the buildings at the ground-floor level, while the street cars are carried across the plaza on an inclined trestle and pass through the head house and between the other buildings at the second-floor level. Space is reserved for two switch tracks on each side of the roadway. A wide ramp on each side of the roadway leads from the lower level of the head house to the second floor, which is at the same level as the passenger-deck floor of the pier. Access to the upper floors is obtained by means of wide stairways. The heating plant and sprinkler supply pumps are located in rooms on the ground floor, while the rooms above will be devoted to administration offices, toilets and a women's rest room. The vestibule and hallways are wainscoted with white enamel brick to a height of 8 ft., and above this level the walls are plastered. The building is entirely fireproof.

FREIGHT AND PASSENGER TRAFFIC WILL BE SEPARATED

The two freight and passenger buildings are each 100 ft. wide and 2340 ft. long.



PIER, LOCATED JUST NORTH OF CHICAGO RIVER, IS 3000 FEET LONG—OUTER END GIVEN OVER TO RECREATION PURPOSES

MEN IN WADING SUITS PLACING SUBMERGED ANCHOR RODS

MOUNTED CHUTE SUPPORT ON ROOF OF PASSENGER DECK

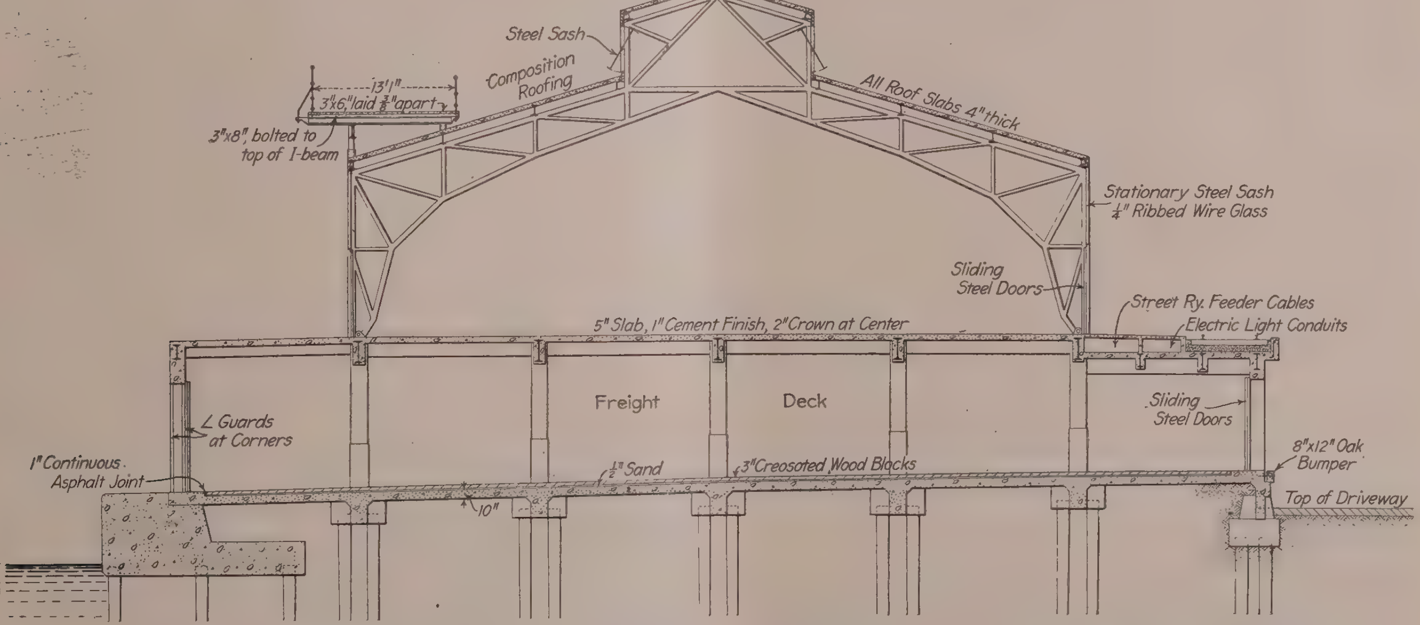
The first-floor beams and slab are of reinforced concrete, while the columns, girders and floorbeams of the second floor are of steel completely fireproofed. The second floor is a reinforced-concrete slab, crowned in the center so as to be easily cleaned by flushing. The wearing surface for the freight deck is creosoted block. The reinforced-concrete roof, covered by five-ply composition roofing, is carried by a three-hinged arch surmounted by a monitor. An 8-ft. boardwalk extends along the water side of each truss from the head house on the west to the terminal building on the east. The live loads assumed are 250 lb. per square foot on the first floor, 200 lb. on the passenger deck, 100 lb. on the board walk and 25 lb. on the roof and monitor.

The first floor is to be devoted exclusively to freight, while the second floor will be reserved for passengers who will pass from the main deck of the boats to the street cars, or vice versa, without climbing any stairs. Street-car operation will all be "single-track one way."

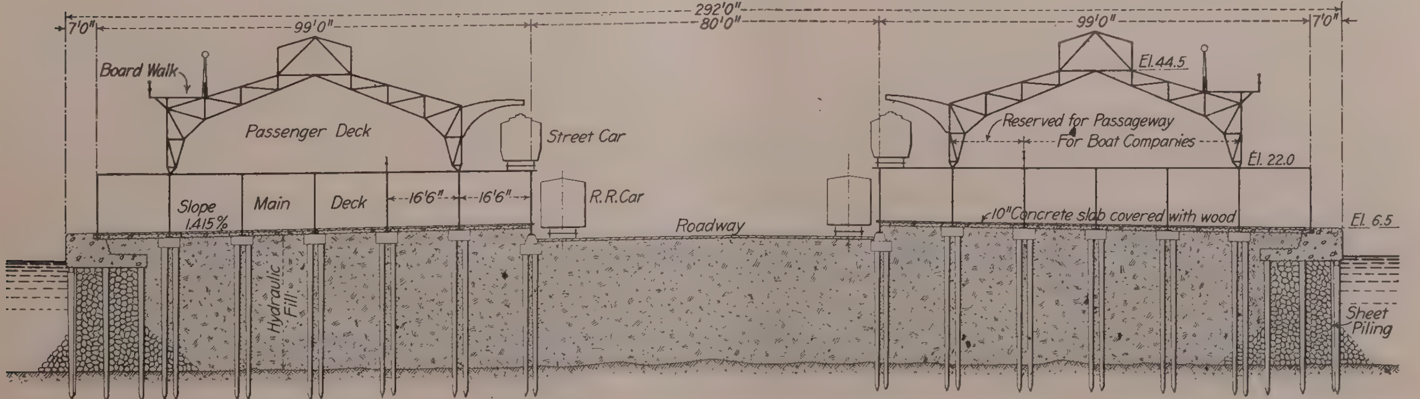
Practically the whole upper half of the side walls is of wire glass set in steel sash, thus doing away with insufficiency of light, a common fault of most freight sheds. The sliding steel doors at the freight level are so arranged that one or more can be opened at a time, thus giving practically any amount of clear opening. The doors of the passenger deck are arranged so as to give a 10-ft. clear opening in each bay.

SLABS DEPOSITED THROUGH ROOF

Concrete in the foundations, girders and first-floor slab was deposited at one operation from a traveling tower outfit set up in the main roadway. Two spouts were maintained, one for each building. For the upper floor the spouts were supported on a large platform mounted to operate longitudinally on the roof. A small trestle



ENLARGED CROSS-SECTION OF ONE OF TWO MAIN PIER SHEDS—NOTE WALK ON ROOF TO RECREATION PAVILION



GENERAL CROSS-SECTION OF ENTIRE PIER—TWO MAIN DOUBLE-DECK PIER SHEDS WITH ROADWAY AND TRACKS BETWEEN

PORTABLE CONCRETE TOWER

was mounted on the platform to run transversely to cover a length of 250 ft. from each setting. Inside the building the concrete was distributed by another rotating chute. The concrete roof slabs were made on the ground and hoisted into place.

Industrial Track

Aggregate for the concrete was delivered in 2-yd. dump cars over an industrial track laid to a sand loading plant on a dock about 1000 ft. distant, and to standard-gage cars loaded with gravel in Illinois Street. The tracks from these two points came together at the very end of Illinois Street, and the dinky hauled to the concrete plant the number of sand and gravel cars proportionate to the mixture being used. The cars were unloaded into the elevator boot, the train being pulled along one car-length at a time by a rope drive from a crab on the hoisting engine. The same spotting procedure was used at the sand loading plant. By using these crabs only one dinky was required. When placing the 10-in. slab and heavy girders, from 200 to 300 cu. yd. could be deposited in an eight-hour shift, but from 150 to 180 cu. yd. only could be placed in the 5-in. slab.

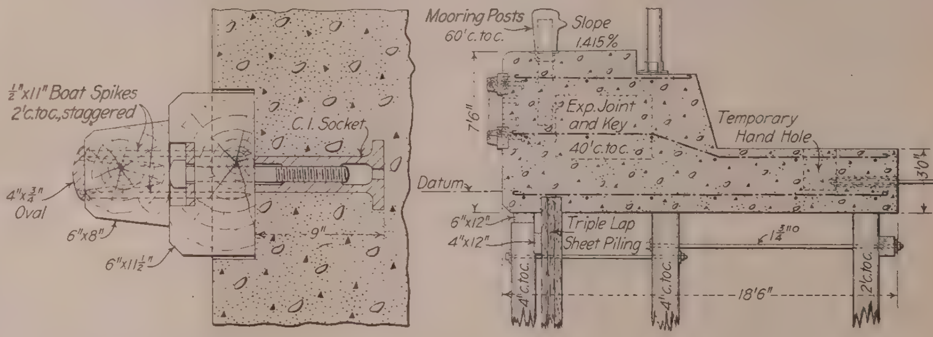
Erection of the steelwork was carried out by means of mounted erectors operating 45-ft. booms with a three-drum hoisting engine. The erection of three bays of steel was an ordinary day's work for each erector.

Work has only begun on the recreation building, but the contract calls for completion by Sept. 15. The three-story structure is 50 x 280 ft. in floor plan and will have a 32 x 280-ft. refectory, an emergency hospital and an auditorium with 4000 seats removable so that the floor can be used for dancing.

Personnel

The Great Lakes Dredge & Dock Company was the contractor for the piling, concrete dock and earth filling for both the pier and approach. The Kettler-Elliott Erection Company has the contract for the street railway trestle and the Chaney-Archibald Company built the head house. Edward L. Scheidenhelm is the general contractor for the freight and passenger buildings. The John Griffiths & Son Company holds the contract for the terminal building and Paschen Brothers & Company will construct the recreation buildings.

The design of the substructure was made under the direction of the Harbor & Subway Commission, originally composed of John Ericson, city engineer, J. J. Reynolds and E. C. Shankland. About a year ago the first two of these resigned and were succeeded by the city comptroller and the commissioner of public works. The design for the buildings was carried out under the immediate direction of E. C. Shankland. William Artingstall, harbor engineer, has direct charge of the work and Charles S. Frost is the architect for the commission.

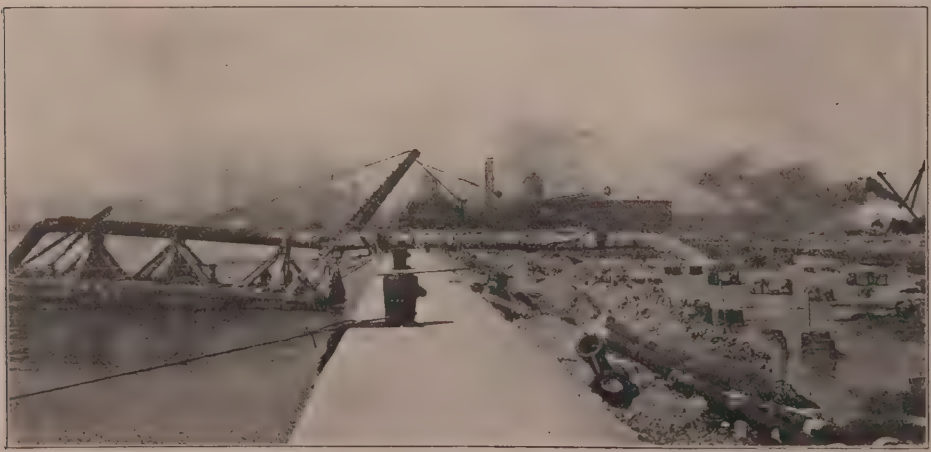


Fender Detail

Section of Dock

FENDER DETAIL AND SECTION OF DOCK, WHICH IS CARRIED ON TIMBER PILES

Water Consumption in Louisville averaged 112.6 gal. daily in 1914.



PUMPING SAND OVER THE DOCK TO FORM THE SOLID FILL CARRYING THE PIER

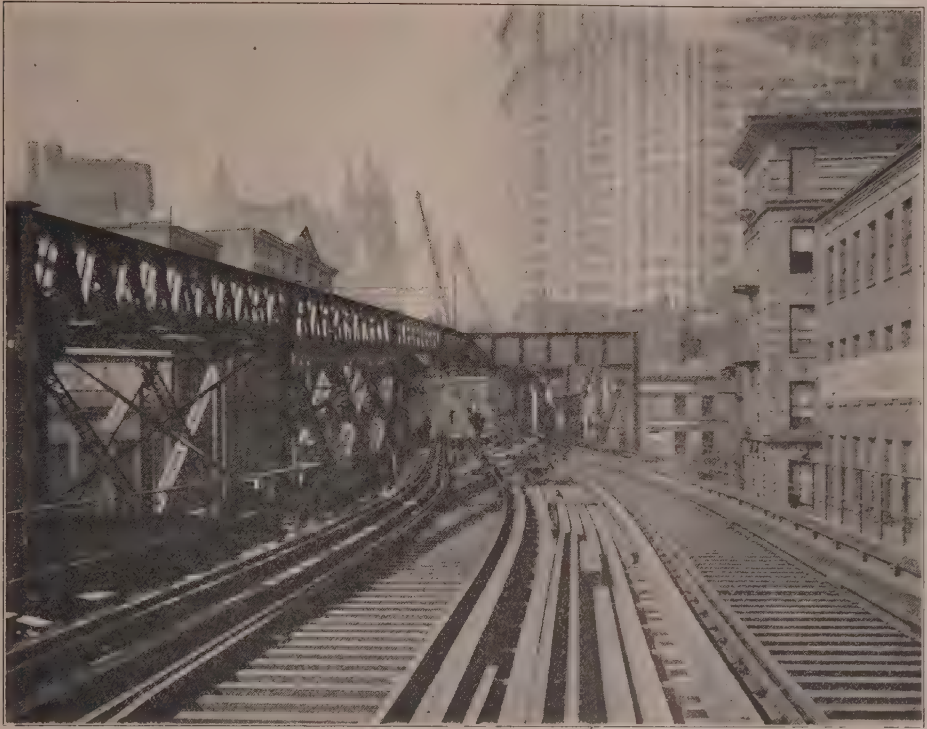
Minnesota Highway Commission Aids in Building Firebreaks

PROTECTION of approximately 800,000 acres of valuable State-owned timber land in Koochiching County, Minnesota, has been partly secured by the construction during the last year of 65 miles of firebreaks and 38 miles of fire-line trail. This work of the State Highway Department acting jointly with the State Forestry Board has made it possible to reach conveniently many heavily timbered districts heretofore inaccessible by ordinary means of travel during the summer. As a result fire-fighting equipment and men can now be easily taken in to protect State timber in the vicinity of firebreaks whenever it may be threatened by fire.

The firebreaks and fire-line trails have been located so as to take advantage of the topography and of existing roads, trails and rivers. By following this plan valuable stands of State timber were more easily protected from fire at a minimum of expense, and routes of travel were opened between the remote communities and their trading centers. Telephone lines were constructed over some of the more remote parts of the firebreaks and connected with the headquarters of forest officers. These lines cost approximately $25 per mile and furnish the cheapest kind of fire protection.

Although some of the firebreaks first constructed were cleared to a width of 4 rods, it was later found advisable for most situations to clear a line only 2 rods wide, and in some cases only 1½ rods. Under the latter conditions it is felt that in addition to the lower initial cost there will be much less trouble in keeping down weeds and brush which might grow up in the cleared strip, and on high ground it is just as effective a fire line, because it is just as suitable for travel and for backfiring.

"Mixed Foundations"—part on solid rock and part on hard blue clay, caused unequal settling, after thirty years, of one of the native limestone buildings at the Rock Island Arsenal. The building is used for shop purposes and consists of two stories, an attic and basement. The unequal settling caused some cracking of the walls and at one place the gable end of the portico was slightly out of plumb. Repairs, according to a letter from the commanding officer, Lieut.-Col. George W. Burr, consisted merely in taking down this portion of the wall, strengthening the foundation and rebuilding the wall. During the prosecution of this work the adjacent floors and roof were supported by timber staging resting on supplemental concrete foundations placed under the basement floor.



NEW UPPER-LEVEL TRACK CONSTRUCTION AT APPROACH TO CITY HALL TERMINUS

Braced columns resting on lower cross girders support stringers on steep grade. Note the long upper cross girders and the required cantilever support in the middle distance.

How Some Problems in the New York Elevated Improvement Work Were Solved

New Girders Connected to Old Columns—Formulas Derived for Bending Moments in Two-Story Bent Subjected to Wind Pressure

INCREASING the rapid-transit facilities of the New York elevated railway by the addition of express tracks has required the solution of many difficult problems. The shifting of old columns and track girders, the replacement of old by new columns on the same foundation, the construction of a double-deck type of station with express track approaches on steep grades, all accomplished without interruptions to traffic either on street or railway, are examples of the work now being rapidly pushed to completion.

Construction and design problems of unusual character have been met on every hand. The manner in which some of these problems were solved, and illustrations of a few details of this work which will involve the addition of nearly 50,000 tons of steel and an expenditure approximately estimated between $8,000,000 and $10,000,000 will here be described. The designing and detailing were of the most intricate and time-consuming nature. At least 1800 general drawings have been made by the Interborough Rapid Transit Company and about 8000 detailed drawings by the contractors, the designing having been started in 1912.

The specific details to be explained in this article include the 6-in. solid steel slabs tapped for screw bolts at the bases of new columns to allow erection where old anchor bolts were left in place, the connection of new cross girders to the existing columns, the double-deck construction near the City Hall and the design formulas for two-story columns with unusual bracket details.

LOADS AND ALLOWABLE STRESSES

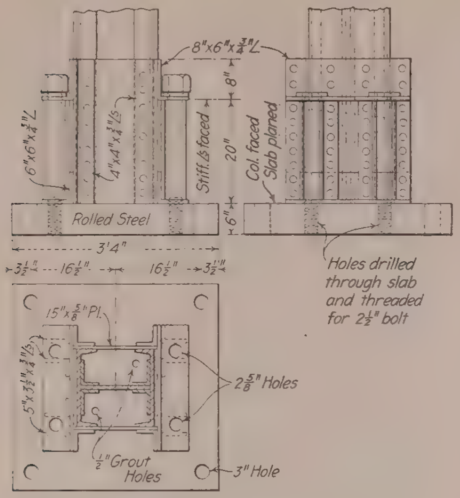
The estimated dead-load weight of the entire suspended structure is 750 lb. per linear foot of track, the track stringers averaging about 45 ft. long. The live load for each track consists of a train of cars, each having two four-wheel trucks 33 ft. on centers with 6-ft. wheel bases, and 15 ft. between truck centers of adjacent cars. Each car is assumed to weigh 35 tons, 20,000 lb. on each front truck axle and 15,000 lb. on each rear truck axle. The live loads for the canopy roof are 30 lb. per square foot and for station platforms 80 lb. Wind pressure is assumed at the usual 30 lb. per square foot on exposed surfaces, on a car 10 ft. high.

The longitudinal force prescribed is 10 per cent of the live load, and structures located on curves are designed for the computed centrifugal force assumed to act at 5 ft. above the rail. Overhead clearance of 14 ft., side clearance of 6 ft., increased as required on curves for cars 48 ft. long and 9 ft. wide, and a minimum clearance of 18 in. between car and columns are specified.

The allowable unit stresses for structural steel, which must comply with the American Railway Engineering Association's specifications (except for rivets) are 9000 for axial tension on net section; $9000 - 40l/r$ for axial compression on gross section (but no column to be smaller than 12 in.); 9000 for bending fiber stress, except for roof beams where 12,000 may be allowed; 7500 and 15,000 for shear and bearing respectively on rivets, and 300 for direct loads on concrete piers or 450 for combined direct and bending stresses. Members subject to both axial and bending stresses may be designed with unit stresses 25 per cent in excess of the allowed axial unit stress. For combined stresses, including wind, the unit

LONG NEW COLUMNS DESIGNED WITH SPECIAL BRACKET SUPPORTS BELOW OLD REINFORCED CROSS GIRDERS

TIMBER BENTS AND LONG PLATE GIRDERS SUPPORT OLD TRACK TRUSSES WHILE NEW 32-TON CROSS GIRDER IS RAISED



SPECIAL ROLLED-STEEL SLAB COLUMN BASE

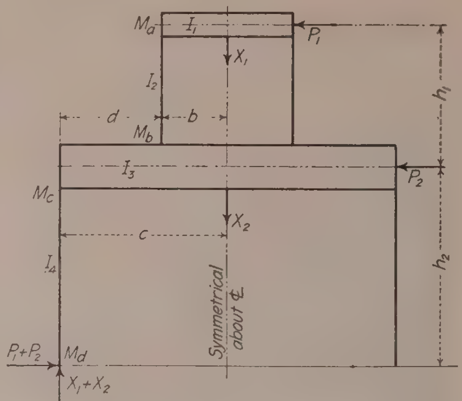
The slab is first lowered over the old outside anchor bolts, then the new column is slipped into place between upper cross girder and slab and bolted with 2½-in. bolts.

stress may be increased 50 per cent. Other usual provisions are prescribed. No impact stress is specified, the unit stresses being low enough to allow for the effect of impact.

SIX-INCH STEEL SLABS FOR COLUMN BASES

In those cases in which new columns had to be erected over old foundation bolts, it was finally decided to adopt the type of column base shown in the accompanying detail drawing. As it was impossible to turn the new columns into place under the old cross girders and over the old projecting bolts, heavy 6-in. rolled-steel slabs with threaded holes to receive the 2½-in. anchor bolts of the new columns were used. These slabs could be slipped over the old bolts, and thus gave a clear smooth surface for sliding the new columns under the cross girders. The old columns and girders were removed by cutting through with the oxyacetylene flame.

In general it was found necessary to increase the depth and bearing area of most of the old brick piers, due to the heavier loading from the added tracks. This was done by temporarily supporting the old columns by riveting a bracket near their base and carrying the load to a pair of horizontal beams; these beams were long enough to prevent the pressure from blocking at their ends to cause the earth to fall into the excavation around the old piers. These old piers were removed by the use of pneumatic drills, and new concrete was placed under the old columns with the anchor bolts retained in their old position.



FORMULAS FOR BENDING MOMENTS IN SPECIAL DOUBLE-DECK SYMMETRICAL BENT

NOTATION GIVEN ON ABOVE DIAGRAM

P_1 and P_2 represent the horizontal forces on half the structure only, the reactions $P_1 + P_2$ at the bases of the columns being assumed equal. Let

$A = P_1bh_1^2/2I_2 + P_1h_1(c^2 - b^2)/2I_3$
$B = (P_1h_2^2 + 2P_1h_1h_2 + P_2h_2^2)c/2I_4$
$C = b^3/3I_1 + b^2h_1/I_2 + (c^3 - b^3)/3I_3 + c^2h_2/I_4$
$D = (c^3 - b^3)/3I_3 + c^2h_2/I_4$
$E = c^3/3I_3 + c^2h_2/I_4$
$F = P_1h_1(c^2 - b^2)/2I_3$

Then

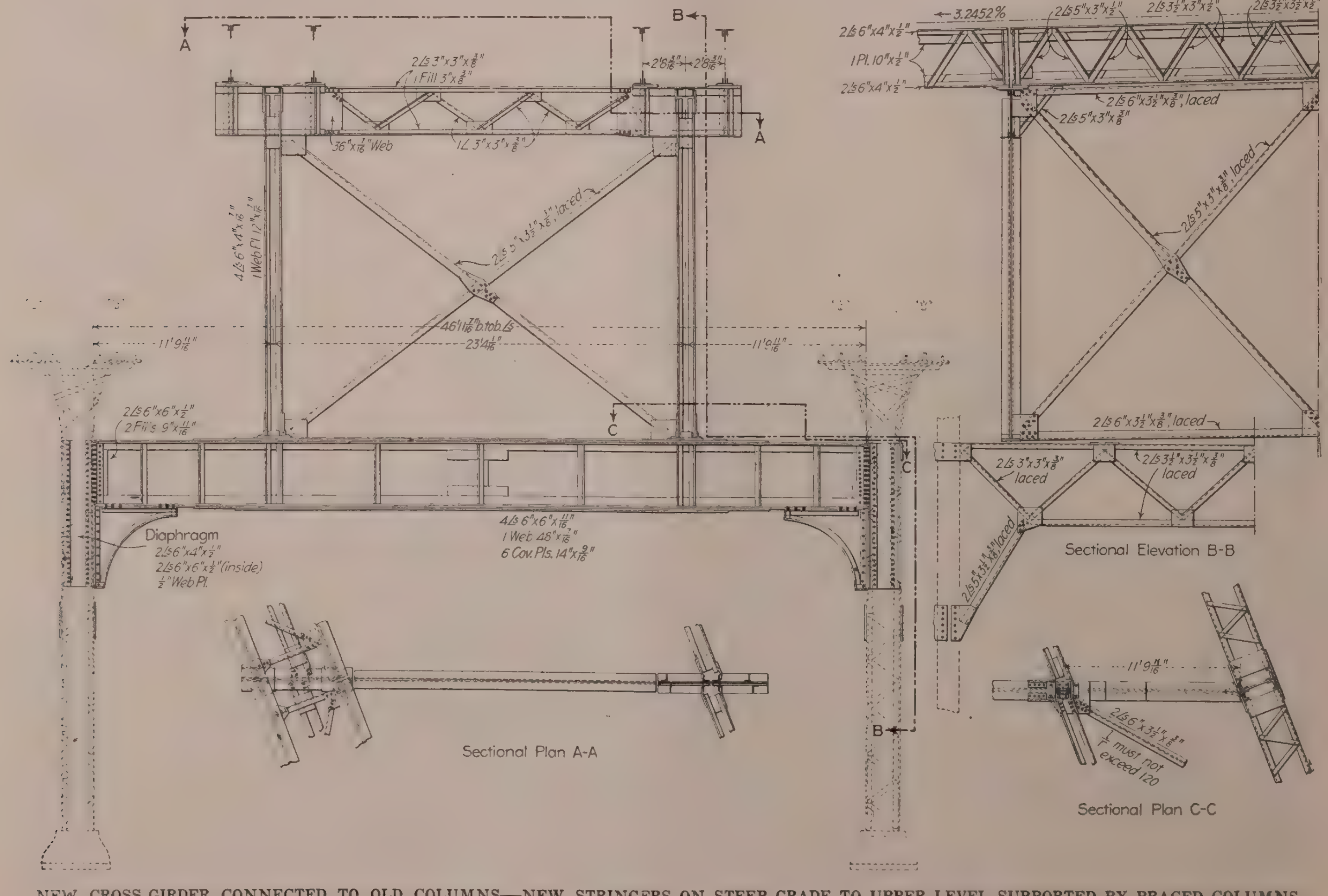
$$X_1 = \frac{(A + B)E - (F + B)D}{CE - D^2}$$

$$X_2 = \frac{(F + B)C - (A + B)D}{CE - D^2}$$

$M_a = -X_1b$
$M_b = -X_1b + P_1h_1$
$M_c = -(X_1 + X_2)c + P_1h_1$
$M_d = -(X_1 + X_2)c + P_1(h_1 + h_2) + P_2h_2$

NEW CROSS GIRDERS CONNECTED TO OLD COLUMNS

On the Third Avenue line in the New Bowery the old columns were found to be sufficiently strong if shortened, when necessary, by knee-braced struts to reduce the length ratio. The two additional tracks were provided here by a double-deck construction as indicated in the accompanying detail drawing. The old columns are composed of two channels laced and bent at the upper ends to give the fan-top type of single-track support typical of this Third Avenue line, as shown by dash lines on the drawing. In order to connect the cross girders to both channels, field-riveted diaphragms were used. They had to be inserted between the channel flanges, which are turned inside, by removing the column lacing on one side, placing one pair of angles, "feeding in" the web, adding the second pair of angles and finally riveting up


A
B
2∠s 3"x3"x$\frac{3}{8}$"
1 Fill 3"x$\frac{3}{8}$"
2∠s 6"
2∠s 6"
36"x$\frac{7}{16}$" Web
1∠ 3"x3"x$\frac{3}{8}$"
4∠s 6"x4"x$\frac{1}{2}$"
1 Web Pl. 12"x$\frac{1}{2}$"
2∠s 5"x3$\frac{1}{2}$"x$\frac{3}{8}$" laced
46'11$\frac{7}{16}$" c. to c. b. ∠s
23'5$\frac{1}{2}$"
11'9$\frac{3}{16}$"
11'0$\frac{1}{16}$"
2∠s 6"x6"x$\frac{1}{2}$"
2 Fill's 9"x$\frac{11}{16}$"
C
Diaphragm
2∠s 6"x4"x$\frac{1}{2}$"
2∠s 6"x6"x$\frac{1}{2}$" (inside)
$\frac{1}{2}$" Web Pl.
4∠s 6"x6"x$\frac{11}{16}$"
1 Web 45"x$\frac{9}{16}$"
6 Cov. Pls. 14"x$\frac{9}{16}$"
Sectional Plan A-A
3.2452%
2∠s 5"x3"x$\frac{1}{2}$"
2∠s 3$\frac{1}{2}$"x3"x$\frac{1}{2}$"
2∠s 3$\frac{1}{2}$"x3$\frac{1}{2}$"x$\frac{1}{2}$"
2∠s 6"x4"x$\frac{1}{2}$"
1 Pl. 10"x$\frac{1}{2}$"
2∠s 6"x4"x$\frac{1}{2}$"
2∠s 6"x3$\frac{1}{2}$"x$\frac{3}{8}$", laced
2∠s 5"x3"x$\frac{3}{8}$"
2∠s 5"x3$\frac{1}{2}$"x$\frac{3}{8}$", laced
2∠s 6"x3$\frac{1}{2}$"x$\frac{3}{8}$" laced
2∠s 3"x3"x$\frac{3}{8}$" laced
2∠s 3$\frac{1}{2}$"x3$\frac{1}{2}$"x$\frac{3}{8}$" laced
2∠s 5"x3$\frac{1}{2}$"x$\frac{3}{8}$" laced
Sectional Elevation B-B
11'9$\frac{3}{16}$"
2∠s 6"x3$\frac{1}{2}$"x$\frac{3}{8}$"
l/r must not exceed 120
Sectional Plan C-C

NEW CROSS GIRDER CONNECTED TO OLD COLUMNS—NEW STRINGERS ON STEEP GRADE TO UPPER LEVEL SUPPORTED BY BRACED COLUMNS.

Open-web stringers and upper cross girder used. Special skew details are shown in sectional plans A-A and C-C.

after drilling field holes in the webs of the channels and the end connection angles of the girders, which were shipped blank. In general all holes which are required to match existing connection holes are drilled in the field.

This bent is on a skew, as shown, and the old track girders at the lower level remain in place. In general, these old iron track girders could be retained, because they had already been reinforced about 15 years ago. The important details to be noted are the new longitudinal bracing, the new upper-level track girders of open-web construction, section CC, and the horizontal strut, shown on section BB, introduced to transfer the horizontal tractive force to the new longitudinal strut in order to decrease the bending in the new cross girders.

In several cases where the new cross girders were supported on top of the old columns the caps of the old columns were reinforced by the addition of new I-beams, channels, plates and angles. Although open-web track girders weigh more and cost more than plate girders, they were used here on the upper level because they cut off less light from the adjacent buildings.

DOUBLE-DECK CONSTRUCTION NEAR CITY HALL STATION

The addition of two tracks to carry the Second Avenue line to the upper level of the City Hall Station required new columns and new cross girders. One of the accompanying photographs shows the type of construction. The upper tracks are carried above the lower for about twenty-six bents from the station terminus, then curved to the east to clear the lower tracks and carried down to the lower level on a 3-per cent grade, the maximum allowable. Heavy plate girders of about 45-ft. span between the new columns support the upper-level track stringers as indicated in the photograph. After the tracks have been carried over to clear the lower-level trains, the descending stringers are carried by short 18-ft. cross girders on columns which are supported by the lower-level cross girders. These columns and the longitudinal and sway bracing can be clearly seen in the photograph.

Another photograph shows the new long outside columns on this section and the unusual type of bracket supporting the old latticed cross girders, which have been reinforced by the addition of new web plates at the end and center. The column web splices can be clearly seen, and the new longitudinal strut with deep knee braces to shorten the unsupported lengths are also shown. It was found that the design requirement that the lateral deflection should not exceed ¼ in. at the top of the columns generally fixed the column sections, which are composed of one channel on the outside, two 6 x 4-in. angles on the inside to allow the use of a wider web at the bracket, and four angles with web to form a built I-section.

The third photograph shows a 32-ton girder, the heaviest on this work, being placed with its top flange angles and cover plates removed in order to hoist it between the ends of the existing stringers. The manner of supporting these stringers by wedging and blocking up from temporary cross girders is also shown, the timber bent and use of these cross girders (or 24-in. Bethlehem girder beams in cases of shorter spans) being typical of the methods used. This girder is located at the corner of Chambers Street and Park Row, and spans about 57 ft. on a skew from curb to curb. It was decreased in depth at the end by curving the lower flange for the sake of appearance.

LEAST-WORK ANALYSIS FOR TWO-STORY BENT DESIGN

In making the design of long two-story columns similar to those above described, and for cases where sway bracing was impossible, exact formulas for bending moments were worked out for assumed symmetrical bents, using the method of least work. These formulas, in terms of the shears X_1 and X_2 at the centers of the cross girders, based upon the assumption of columns with fixed ends and a symmetrical structure acted upon by horizontal wind pressure are here reproduced for the case of an assumed upper story narrower than the lower story, using the notation given on the figure. Simpler formulas for the usual case where the upper story is the same width as the lower are easily derived by making $c = b$ in the equations given. The resulting equations can be simplified by canceling out of each term in the constants A, B, C, D and E a term c or d to the first power, as they would cancel out when substituted in the equations for X_1 and X_2. It should be noted that the horizontal wind forces shown are for one-half of the structure only.

The large bending moments at the lower cross girder in the columns already considered made it necessary to enlarge the column section by the wider web shown in the photograph in order to develop the required resisting moments. The detail using this spliced type of web is seen to be effective in increasing the moment of inertia where needed, and at the same time affords a seat for the main cross girders.

The design and general details of this work have been prepared under the direction of George H. Pegram, chief engineer, F. W. Gardiner, principal assistant engineer, and S. Johannesson, assistant engineer of the Interborough Rapid Transit Company, and the construction is being pushed rapidly by the T. A. Gillespie Company, executives, Terry & Tench and Snare & Triest, contractors.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

The Money in the Till

SIR: At the May meeting of the Association of American Portland Cement Manufacturers, I tacked up a large placard giving a statement illustrating the losses on cement at various prices. I have received a large number of requests for copies of this statement.

I have shown the capacity, which is the amount that could be made if all the machinery ran 365 days a year. The output is the practical capacity. The other figures shown in the first column of the table are the number of barrels manufactured and shipped should the mill run 75 per cent of the practical output and 62½ per cent of the practical output. The overheads remain the same whether the plant runs full or only 75 or 62½ per cent. The manufacturing cost is varied with the output. Most mills claim that if they run full their

STATEMENT OF LOSSES OF CEMENT AT VARIOUS PRICES

No. Bbl. Made and Shipped	Administration, Sales and Overheads not Charged to Mf.*	Depreciation, Obsolescence, etc. @ 7½c per bbl. per annum	Mfg. cost on cars	PROFIT SELLING PRICE 75 cents	 70 cents	 65 cents	 60 cents
Capacity 1,125,000 bbl.							
Capital $1,250,000.				3^6 per cent.			
Output 1,000,000. bbl.	$ 80,000.	$ 75,000.	55c	$ 45,000.	*$ 5,000.*	*$ 55,000.*	*$105,000*
750,000. bbl. 75 per cent.	80,000.	75,000.	57c	*20,000.*	*57,500.*	*95,000.*	*132,500*
625,000. bbl. 62½ per cent.	80,000.	75,000.	59c	*55,000.*	*86,250.*	*117,500.*	*148,750.*
Capacity 2,225,000 bbl.							
Capital $2,500,000.				5^6 per cent.	1^6 per cent.		
Output 2,000,000. bbl.	$150,000.	$150,000.	53c	$140,000.	$ 40,000.	*$ 60,000.*	*$160,000*
1,500,000. bbl. 75 per cent.	150,000.	150,000.	55c	None	*75,000.*	*150,000.*	*225,000*
1,250,000. bbl. 62½ per cent.	150,000.	150,000.	57c	*75,000.*	*137,500.*	*200,000.*	*232,500*
Capacity 4,500,000 bbl.							
Capital $5,000,000.				6^8 per cent.	2^8 per cent.		
Output 4,000,000. bbl.	$280,000.	$300,000.	52c	$340,000.	$140,000.	*$ 60,000.*	*$260,000.*
				1 per cent.			
3,000,000. bbl. 75 per cent.	280,000.	300,000.	54c	50,000.	*100,000.*	*250,000.*	*400,000*
2,500,000. bbl. 62½ per cent.	280,000.	300,000.	56c	*105,000.*	*230,000.*	*355,000.*	*480,000*
Capacity 9,000,000 bbl.							
Capital $10,000,000.				7^2 per cent.	3^2 per cent.		
Output 8,000,000. bbl.	$520,000.	$600,000.	52c	$720,000.	$320,000.	*$ 80,000.*	*$480,000*
				1^4 per cent.			
6,000,000. bbl. 75 per cent.	520,000.	600,000.	54c	140,000.	*160,000.*	*460,000.*	*760,000*
5,000,000. bbl. 62½ per cent.	520,000.	600,000.	56c	*170,000.*	*420,000.*	*670,000.*	*920,000*

*No interest on Bonds in these Calculations.
Ital cs indicate loss.

EXAMPLE

2,000,000. bbl. Sold @ 65c	$1,300,000.
2,000,000. bbl. Cost 53c	$1,060,000.
	$ 240,000.
Fixed Overheads	$ 300,000
LOSS	*$ 60,000.*

manufacturing cost is less than if they ran 75 or 62½ per cent. This statement is therefore made up based on this argument. The figures not in italics show profit and the percentages above them are the percentage of profit on the capitalization. The manufacturing cost includes loss on the bags and the packing and loading costs.

I have given an example as to how the figures are arrived at so that any one who desires to use his own figures may make up a similar statement.

New York City. ALBERT MOYER.

Pile-Driving Specifications

SIR: The letter of Paul Muñoz, on page 660 of the Engineering Record of May 22, 1915, anent pile-driving specifications, and your editorial comment on it in the same issue, bring up some interesting points on which the writer has had some experience.

About seven years ago the writer designed a foundation for a building in New Orleans, and later superintended the driving of the piles. There were about 3000 piles. Borings were first made, and the general elevation of the stratum on which the piles were to rest was determined. The drawing gave the elevation of the cutoff. The contractor was thus enabled to get a fairly accurate estimate on the lengths of piles required and made a lump-sum price. There were, of course, unit prices for the lumber, and it was provided in the contract that allowance should be made for any extra piles required.

The cellar elevation was from 12 to 20 ft. below the curb, but in the beginning only 5 or 6 ft. of soil was removed and then the pile driving was begun. When a pile was driven to soil a short pile with a metal sleeve was placed on top and the original pile driven to the supporting stratum. The short pile, called the follower, was then withdrawn. The lot was later excavated to the top of the piles. Of course there was some variation in the slope of the supporting stratum, and some variation in the amount of penetration required, the stratum varying in density as well as slope. Enough allowance in the length of pile had to be made for this variation and in addition 2 ft. for the damage due to the splintering of the butt.

In every pier or cluster of piles the writer caused one test pile to be driven. This pile, instead of just penetrating the stratum, was driven right through. Where the stratum was evidently quite shallow more piles were added to the pier. It might be added that it is always necessary to give the engineer on the ground this latitude. Piles are driven as a rule in ground whose nature is more or less uncertain. The design as made in the office must be somewhat of a guess, which should be changed to suit the actual conditions found in the field.

A pile derives its supporting power from two sources—skin friction and its action as a column when resting on a firm stratum. It is the belief of the writer that it is better to stop driving the pile when it reaches a firm stratum, even if the latter is but 2 or 3 ft. deep, than to pierce the stratum and depend on the increased area of skin friction of a longer pile. Of course, the supporting stratum must be low enough so that any quicksand bed it may rest on cannot be tapped. Some of the test piles mentioned would be penetrating at the rate of about ¼ in. with a 5-ton hammer on a 3-ft. drop, but the minute the stratum was pierced the movement would be 2 or 3 ft. per blow and these piles would have been lost entirely had they been driven to anything like the resistance of the others.

A few blocks away from the site in question, where the formation was practically the same, a Government building was being erected. The specifications read that a certain size and length of pile be driven. This was rigidly adhered to, as much as 45 min. being spent on some piles. It was very evident that the final penetration was really a deception, for through this terrific punishment the piles undoubtedly broke. Here was a case where the rigid enforcement of specifications resulted in an injury to the owner as well as to the contractor.

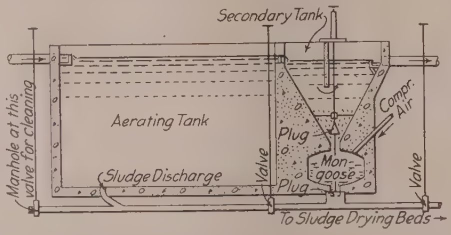
DAVID GUTMAN.

Mount Vernon, N. Y.

Activated Sludge and the Baltimore Sewage Experiments

SIR: The article, "Co-operation Sought in Conducting Activated Sludge Experiments at Baltimore," in the Engineering Record of April 24, is accompanied by an insert stating that "criticisms and suggestions are solicited in order that the Baltimore tests may have the benefit of the experience of all those who have done work or developed theories relating to this newest phase of the sewage treatment problem."

During 1911-1912, and a part of 1913, the writer was in charge of the investigations, designs and construction for sewage treatments in Buenos Aires, Argentina, and while so engaged, and as a result of studies undertaken in connection with this work, formulated a scheme of treatment somewhat resembling the activated sludge process. It was, however, my idea that media were necessary for bacterial growth, and I proposed to fill the aerating tank with broken stone, much along the same lines as have been followed at the Lawrence Experiment Station. Unfortunately, I was obliged to defer the construction of a test plant, and have not had an opportunity since that time to take the matter up again.



TANK SUGGESTED BY BUENOS AIRES STUDIES

What I wish to bring to your attention is the arrangement I had in mind to facilitate operation with the continuous flow, and which I believe may be successfully applied to the activated sludge process.

The continuous agitation in the aerating tank will, of course, prevent the deposition of suspended matter and, if continuous flow is utilized, a portion of such matter, entirely or wholly unoxidized, will pass out in the effluent. To intercept such suspended matter, I proposed to connect a settling tank in series with the aerating tank, through which the effluent of the latter would flow. This secondary tank was to have a hopper-shaped bottom with very steep sides, communicating with a "mongoose." The passage from the hopper to the mongoose was ordinarily to be left open, so that deposited matter would pass down into the mongoose, after the slot action of an Imhoff tank. From time to time, at frequent intervals, a plug valve would be closed, and compressed air admitted from the aerating system at low pressure into the mongoose, forcing the sludge accumulations, not too violently, through a connecting pipe into the aerating tank, at its bottom, for further treatment. This action could be readily made automatic. The outlet from the mongoose should be closed when the inlet is open in order to prevent an upward flow through the mongoose from the aerating tank. The accompanying sketch will illustrate the idea more clearly.

When the sludge accumulation has become too great, a portion may be discharged by closing the passage between mongoose and aerating tank, and emptying the mongoose through suitable connections onto sludge-drying beds as frequently as may be desired.

As there should be no considerable lift from mongoose to aerating tank, and as the compressed air required may be derived from the aerating installation, operation with continuous flow may be secured without any complication of the apparatus required for a "draw-and-fill" plant.

I believe that such an arrangement as I have described would give more satisfactory results than the modified Imhoff tank illustrated in the article in the Engineering Record, as in my opinion aeration will cause an upward flow through the slots as well as through the central vent, causing suspended matter to be carried over into the effluent trough, or in any case will prevent the deposition of matter through the slots, although the air does not actually pass upward through them.

W. S. COULTER,

With Lederle & Provost, Sanitary Experts and Hydraulic Engineers.

New York City.

A POISON FOR JOHNSON GRASS, one of the rapidly spreading plant growths that impede the flow of water in irrigation canals in the Southwest and add greatly to maintenance costs, has been used successfully on a project in Arizona, states the "Reclamation Record." Photographs show that a rank growth was removed in seven weeks. The poison is marketed under the name of "Dinamine." Accurate costs were kept of its use on the worst-infested canal, on which a length of 3100 ft. and an area of approximately 49,000 sq. ft. were covered. The labor cost amounted to $325.75, and 101 gallons of poison at $1 per gallon were used, making a total cost of $426.75. The soil was very heavy adobe, making it very difficult to get the borders thoroughly saturated before applying the poison. This is the heaviest cost, states the "Reclamation Record," as small trenches had to be dug along the top of the banks before they could be wet to a sufficient depth. These trenches, however, are not necessary in sandy soil unless the slopes are very steep. The first wetting was about two-thirds of the total labor cost. The surface of the ground should be kept damp for at least one week after applying the Dinamine, so that the fluid will penetrate deeper into the ground. The use of this preparation is found to be more effective during warm cloudy weather than at any other time.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

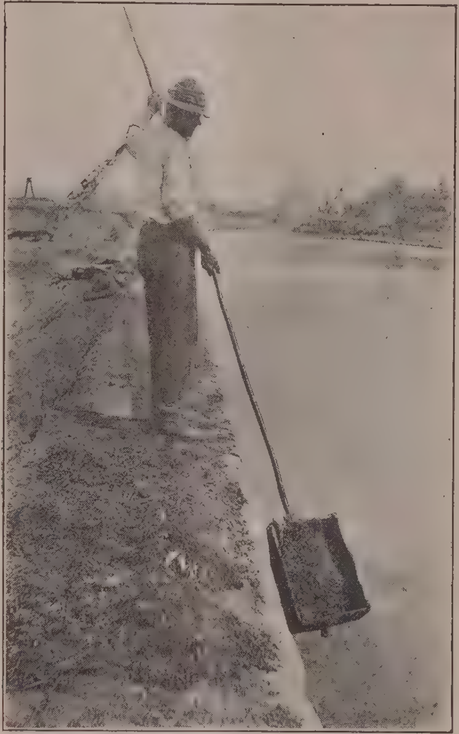
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Chopped-Up Rope and Cinders Stop Leaks in Wall

PLUGGING seep holes in the old wall of the Portland Canal at Louisville, Ky., is accomplished by the means shown in the photograph. The canal is being widened under service and as material behind the wall is removed the hydrostatic head increases. Furthermore, shots in blasting the rock to the required depth, 10½ ft., often cause leaks to develop in the wall as far away as 800 ft. Wooden wedges are driven into the crevices on the back of the wall to stop large flows and the seepage is reduced to a minimum by a mixture of sand, cinders, chopped-up old rope and manure, which is let down on the water side of the wall in a box with a long handle. The open side of the box is placed against the face of the wall, and slowly dragged up and down over the assumed area of leakage. The flow of the water into the leak, coming through holes in the bottom of the box, carries this fine material into the crevices and plugs them.

The work of widening the canal for the U. S. Government is being carried out by the Henry Bickel Company, with A. G. Butler as superintendent.

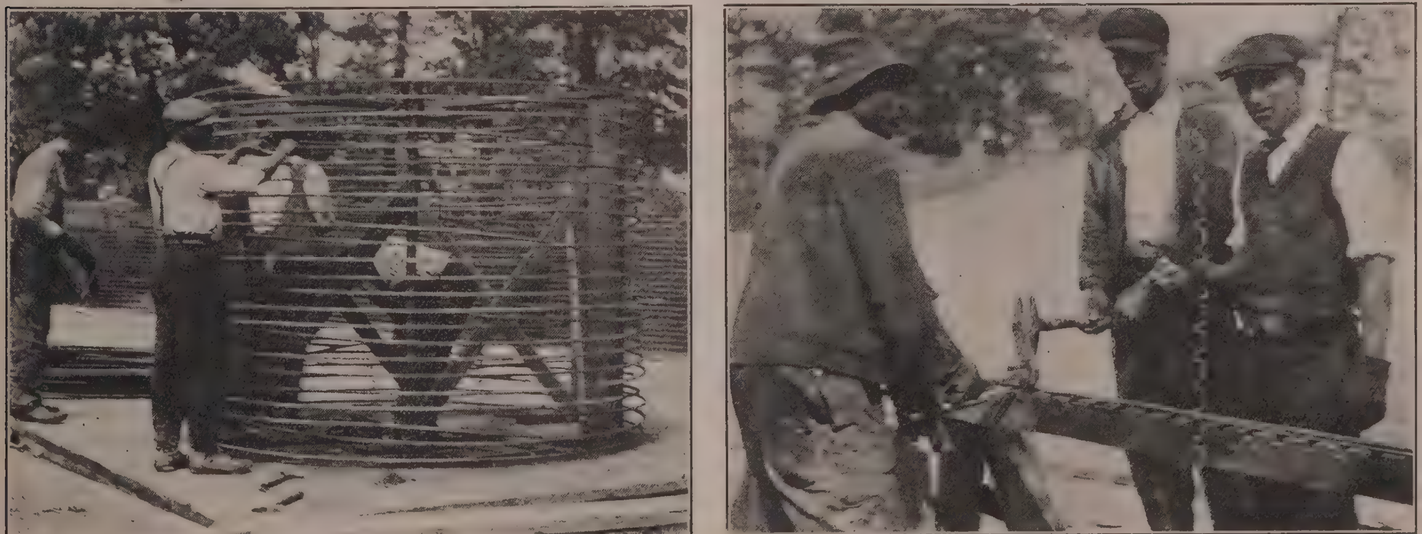


BOX READY TO BE PLACED OVER LEAK IN LOUISVILLE CANAL WALL

Holds Pipe Reinforcement While Wiring Is Being Done

IN ORDER to hold circular rod reinforcement securely in place the Lock Joint Pipe Company, of New York, bends a 1/16 x ½-in. steel strap so as to fit over the bars, as shown in the accompanying photograph. The straps are bent by hand, using a hammer with two projections, one rounded, for striking the first blow, the other square-headed, for the finishing. On the Baltimore water-supply work (described in the Engineering Record, Oct. 31, 1914, page 474) two men easily bent twenty-five strips an hour. Since their wages were 25 cents an hour each, the bending cost 2 cents per strip, or, since the strips were 6 ft. long when bent, 1/3 of a cent per foot.

In service the reinforcing rods are first supported on nails driven in a wooden form, as shown in another of the views. At twelve points around the circumference of the 108-in. pipe, these "clamp bars," as they are called, are used, a ½-in. square bar being placed on the other side of the rods and securely fastened to the clamp bar by a light wire. The result is a stiff cage that can be rolled about or lifted by a crane without danger of distortion.



HOOPED REINFORCEMENT FOR CONCRETE WATER PIPE, AND LABORERS MAKING CRIMPED BARS TO SPACE THE HOOPS

Unit Costs for Day Before Obtained on This Job by 8:30 A.M.

DAILY unit labor costs on all phases of the Chicago, Rock Island & Pacific Railway track elevation work are ready by 8:30 a.m. for the preceding day. This enables the cost engineer, J. M. Weir, to get his data "hot" so that he can make an imme-

CHICAGO TRACK ELEVATION
Daily Unit Labor Cost Report
For work performed..........1915.
Mass concrete
Amount placed this date ....cubic yards
" " to date .... " "
Average unit cost this date ....per cubic yard
" " " this season .... " " "
Reinforced piers, etc.
Amount placed this date ....cubic yards
" " to date .... " "
Average unit cost this date ....per cubic yard
" " " this season .... " " "
Reinforced slabs and girders
Amount placed this date ....cubic yards
" " to date .... " "
Average unit cost this date ....per cubic yard
" " " to date .... " " "
Excavation
Amount taken out this date ....cubic yards
" " " to date .... " "
Average unit cost this date ....per cubic yard
" " " to date .... " " "

CHICAGO TRACK ELEVATION
Weekly Unit Labor Cost Report
Week Ending...........1915.
Mass concrete
Amount placed this week ....cubic yards
" " previous week .... " "
" " to date .... " "
Average unit cost this week ....cubic yards
" " " previous week .....per " "
" " " to date .... " " "
Reinforced piers, etc.
Amount placed this week ....cubic yards
" " previous week .... " "
" " to date .... " "
Average unit cost this week ....per " "
" " " previous week ..... " " "
" " " to date .... " " "
Reinforced slabs and girders
Amount placed this week .... " "
" " previous week .... " "
" " to date .... " "
Average unit cost this week ....per " "
" " " previous week ..... " " "
" " " to date .... " " "
Excavation
Amount taken out this week .... " "
" " " previous week .... " "
" " " to date .... " "
Average unit cost this week ....per " "
" " " previous week ..... " " "
" " " to date .... " " "

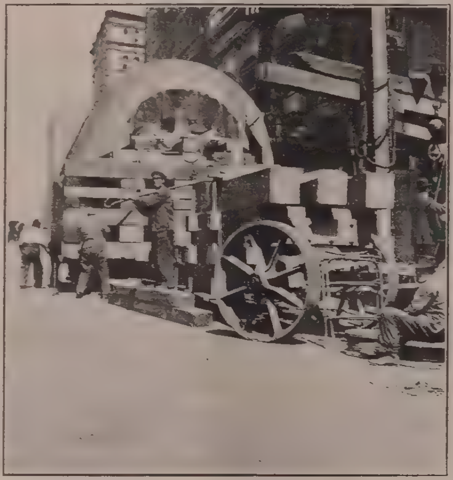
diate check upon all the elements of the work and remedy any increase in costs. The accompanying form is being used and is in accordance with those that the Interstate Commerce Commission has ordered the railroads to put into effect in July. Items not listed are added as needed. The Rock Island engineers keep unit costs on cutting, bending and placing reinforcing rods and form work in units per square foot. Unit costs are also kept on placing and pulling sheeting, but are not listed on the daily reports, as the data are not complete until each section of retaining wall has been finished.

Heavy Truck and Rigging Used to Install 48-Ton Armatures

FOUR ARMATURES, weighing, with the trucking cradle, 45 to 48 tons each, have been lately hauled from Thirtieth Street and North River to the West Thirty-ninth Street transformer station of the New York Edison Company, unloaded, raised to the second floor and installed. A large number of smaller pieces, weighing from 1 to 25 tons each, have also been placed in the same building. What is said to be the largest capacity truck in the country was used to haul the armatures, while a 25-ton capacity motor truck was used to transport the fields and heavy transformers.

Both trucks were built by the rigging contractor, Richard Doughty. The truck shown in the photograph has handled safely a 65-ton load. Its rear axle is a bar of tool steel 6 in. square. Its wheels are of cast-steel, the rear pair having 12-in. treads and weighing 2200 lb. apiece. The treads are crowned to eliminate the cutting of asphalt pavements and skidding in crossing car tracks. The wheels are covered by patents. The truck is hauled by three or four 5-ton Sampson motor trucks, driven light. These trucks are preferred because of their large friction disk clutch and heavy transmission gear, which allows the load to be started easily.

In hauling such a load through crowded streets speed is not a factor, as under no circumstances could more than four miles per hour be made. Several trucks are used in preference to one, with its traction increased by weighting, as this puts less strain on each truck, and as the extra units are needed to hitch on to the rear axle and help slew the big truck in taking sharp corners. The latter follows the motor truck tracks very closely, which greatly reduces the number of manhole covers broken in a trip with a heavy load.


THIS TRUCK HAS CARRIED 65-TON LOAD

On reaching the station, the heaviest parts are raised by a two-spool electric winch on top of the steel gantry, erected over the sidewalk, as shown in one of the views. The 25-ton motor truck can back under this gantry, but the heavy truck cannot. The crib carrying each armature was therefore pulled sideways off the truck on to the sidewalk on rollers. Power for this was supplied by running a line through a snatchblock to one of the 5-ton motor trucks.

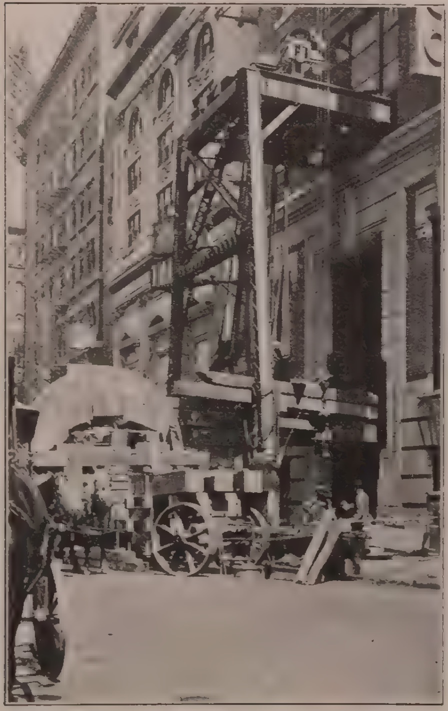
The lifting tackle consists of two sets of falls, each containing eleven parts of 2-in. manila rope. One is attached to each side of the crib with a heavy wire rope sling. Each armature was raised to the second floor and held suspended while four heavy timbers were rolled under it, two from each side. Each was then lowered to rollers and pulled inside the building, where a 50-ton hand-power traveling crane could raise it to the third, or generator floor, and mount it.

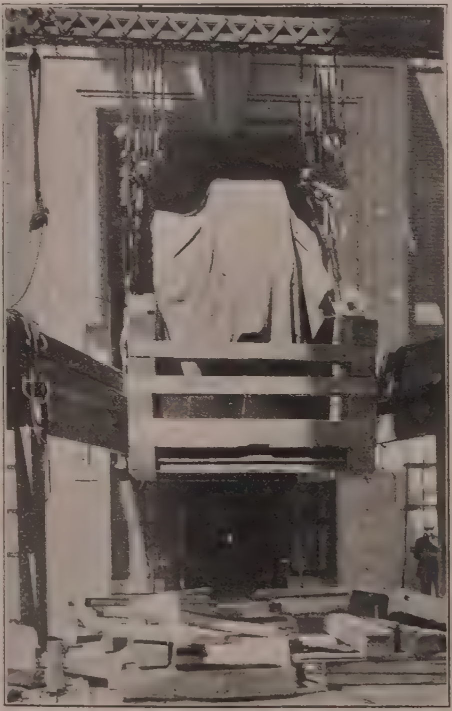
The pieces weighing less than 10 tons, most of which are storage batteries mounted on the upper floors, are handled by a steel stiffleg derrick with a 30-ft. boom, mounted, with its electric hoist, on the roof. Both the gantry and the derrick frame into the steelwork of the building, and both can be dismounted and stored inside the building for future use after the installation is complete. Each stiffleg of the derrick is anchored to a building column by a pin housed in a metal casing to protect it from the weather.

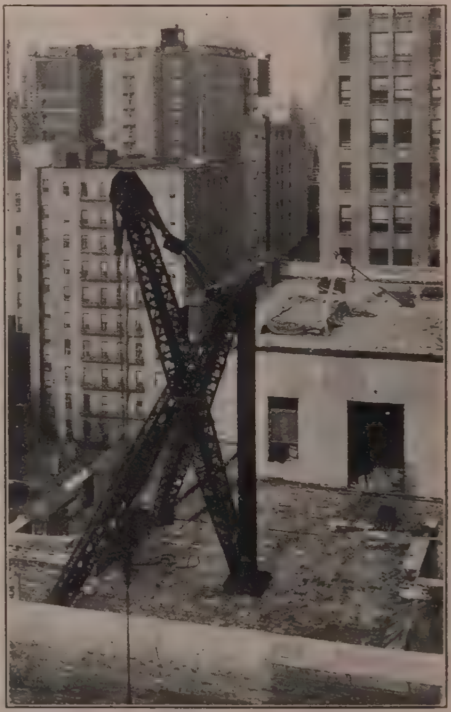
Do Not Break Dynamite Cartridges or Carry Matches When Loading

DYNAMITE cartridges should never be broken in two, according to the "DuPont Magazine." This dangerous practice is forbidden by law in many countries. Hardly a winter passes without some blaster being killed by breaking a dynamite cartridge. When the dynamite must be exposed, the cartridges should be slit lengthways with a sharp knife.

Another dangerous practice indulged in by many rock men is carrying matches in their clothes for lighting their pipes, blasting fuses, etc. Instances are on record of an entire loading gang being killed from an explosion caused by dropping a match from one of the men's pockets into the hole, causing the blast to go off while it was being tamped. If fuses are lighted with matches, one man should have charge of them and leave them at a safe distance while loading the hole.


ELECTRIC WINCH MOUNTED ON GANTRY


RAISING 48-TON LOAD WITH MANILA ROPE


DERRICK IS PART OF BUILDING FRAME

Falls of derrick on roof show in left view. Hoist is just inside door of penthouse in right view. Heavy timbers in left and center views were rolled under armature after it was raised, and used to skid it inside building.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

$20,000,000 Cement Company Receives Charter

Concern with Chicago Headquarters, Projected by Edward M. Hagar, Announces Appointment of Officers

A charter was granted on June 9, under the laws of Maine, incorporating the cement company projected by Edward M. Hagar, who lately resigned the presidency of the Universal Portland Cement Company for the purpose of organizing a company to acquire and operate a chain of cement plants to cover the territory between the Atlantic seaboard and the Rocky Mountains. The concern is called Hagar Portland Cement Company and its capital stock is $20,000,000, all common.

Mr. Hagar announces the election and appointment of the following officers and assistants: Edward M. Hagar, president; Morris Metcalf, vice-president; B. H. Rader, vice-president and sales manager; Gordon Wilson, secretary and in charge of cost accounting; Leonard Wesson, assistant to president in operation and construction; J. P. Beck, assistant to president in extension work; C. W. Lyon, engineer of economics; J. H. Barbazette, superintendent of construction.

Pending the election of a permanent treasurer the office will be filled by Gordon Wilson. The general offices of the company are located at 208 South LaSalle Street, Chicago.

$24,000,000 Railroad Contract Awarded in Canada

A contract has been awarded to the National Engineering Company, of Cleveland, for the construction of the Lake Huron & Northern Ontario Railway, in Canada, running from Sault Ste. Marie to a junction with the Grand Trunk Pacific Railway between Cochrane and Hearst. The line is to be 300 miles long and the estimated cost is $24,000,000. Active construction will await completion of the flotation of a bond issue now being arranged by the National Engineering Company.

Niobrara River Raises Havoc with Nebraska Bridges

All bridges along the Niobrara River for 75 miles from Carns to Niobrara, Neb., are either out or damaged, according to word received from George E. Johnson, State engineer. These bridges were built from the north bank to an island in the center of the stream. The south channels were closed up and as the waterway of the bridges was not large enough to take care of the last May rains, the bridges either went out or the river cut around them.

Only two spans of the bridge at Butte are left. Half the river at the Whiting bridge is running through the fill, south of the bridge. At Lynch the waters are practically all running through the fill south of the bridge and, east of Lynch, the bridges were carried out entirely.

Supervising Engineers Lose Positions on Reclamation Service Work

As a sequel to the recent order transferring the bulk of the U. S. Reclamation Service business from Washington to Denver, Sidney B. Williamson, chief of construction, with headquarters now at Denver, issued an order May 28, effective June 15, abolishing the positions of supervising engineers on the Pacific, Southern, Central, Idaho, Northern and Yakima divisions and requiring all their records sent to the Denver office. This terminates the connection of E. G. Hopson and C. H. Swigart, with the service. A few supervising engineers from the Northern, Central and Idaho divisions will be brought to Denver with the title "senior engineer." Others will remain on the projects with reduced responsibilities. E. H. Baldwin from the Southern division will go to Denver as assistant chief of construction, all project managers will henceforth report to the Denver office instead of to Washington.

McGraw Papers Win Exposition's Medal of Honor

International Jury at San Francisco Makes Award for General Excellence to Engineering Record's Publisher

A medal of honor for general excellence, the highest award which it is possible to confer upon a publishing company, has been given to the McGraw Publishing Company, Inc., by the jury of awards of the Panama-Pacific International Exposition. In addition to the Engineering Record the McGraw Company issues the *Electrical World, Electric Railway Journal, Metallurgical and Chemical Engineering* and the McGraw Directories, including the newly published waterworks directory.

Circuit Court Gives Decision in Second Caisson Patent Suit

A decision just handed down in the United States Circuit Court by Judge William H. Hunt holds that certain patents assigned to the Foundation Company, of New York, are valid and have been infringed by the defendant, the O'Rourke Engineering Construction Company. These patents were held to cover the construction of concrete building caissons, either by removing the outside forms and sinking a plain concrete shaft, or by building them with reinforced-concrete working chambers having steps, so as to give a square bearing on the seal, and to make a continuous concrete shaft to contain no wood. The patents also were held to cover the use of collapsible shafting which can be removed and used over again on other caissons. The suit was over the construction of the foundations for the Walker-Lispenard and other New York buildings constructed by the defendant.

The injunction has been suspended, pending appeal, under a bond given by the defendant.

Ready to Start Miami Flood Prevention Work

Following the decision of the Ohio Supreme Court June 4, declaring the Ohio Conservancy Act valid, the Dayton Flood Prevention Committee has rendered a report, setting forth the history of the flood prevention project and its present status.

The report emphasizes that active work will be undertaken immediately looking toward the construction of the flood prevention work. While the exact date for the letting of contracts is contingent upon formal organization of the district under the law and the making up of the appraisal roll, preparation of the necessary construction plans and specifications is now at hand.

Announcement has been made that the proposed reservoir at Port Jefferson has been abandoned, final surveys and the balancing of reservoirs indicating that it could be dispensed with, but the total capacity of this system has been more than compensated for by the increased capacity in the other six.

It is reported that Mr. Morgan is successfully recovering from his recent operation and will soon devote all of his time to the Dayton work.

"Mushroom" System Infringes Norcross Patents, Court Rules

On Appeal C. A. P. Turner Is Enjoined from Further Use of Flat-Slab Type of Concrete Construction Covered by Drum Claims

Reversing the decree of the U. S. District Court of Minnesota, filed Dec. 27, 1913, the Circuit Court of Appeals has declared C. A. P. Turner's flat-slab patents Nos. 985,119 and 1,003,384 to be an infringement of the Norcross patents controlled by John L. Drum, and a writ of perpetual injunction has been issued enjoining Mr. Turner from "using or vending reinforced-concrete floorings for buildings containing or employing the invention described and patented in the Norcross letters patent No. 698,542," granted April 29, 1902. The decree states that the Turner patents, No. 985,119, granted Feb. 21, 1911, and No. 1,003,384, granted Sept. 12, 1911, conflict with the Norcross claims, particularly with claims 1, 3 and 4.

Judge Wilbur F. Booth of the U. S. District Court has appointed Howard S. Abbott master, to make an accounting of Mr. Turner's profits and of the damages suffered by the plaintiff by reason of the infringement. The court also ruled that the plaintiff recover from the defendant the costs of the suit in both the District Court and the Court of Appeals. The court's mandate was filed June 9. The decision is of far-reaching importance in the field of reinforced-concrete construction, for the Turner "mushroom" system was used extensively throughout the country.

The case of John L. Drum vs. Claude A. P. Turner was first brought up for a hearing Nov. 12, 1913. The District Court at that time dismissed the Drum complaint and ratified the validity of the Turner patents. The case was forthwith carried to the Circuit Court of Appeals which reversed the decision of the lower court and ordered the case to be remanded to the District Court with directions to render a decree in favor of the complainant for an accounting and an injunction.

Mr. Turner's Statement

When the news that the court's mandate had been filed on June 9 was received, the Engineering Record requested a statement from Mr. Turner. In a telegram dated June 17 he says:

"The Circuit Court of Appeals' decision does not end the litigation. It affects only the litigants in view of the present complete evidence as to prior use, etc., rendering the Norcross patent invalid. I will furnish this evidence to any one interested. The litigation concerning the Turner patent is just well under way. No decision has yet been rendered on the broad Turner patent in the Lauter Piano Company's suit in the District Court of New Jersey now ready for a hearing. This case will be decided soon."

Illinois Engineers' License Law Passed by House

The Illinois bill licensing structural engineers, fostered by the Western Society of Engineers, has been passed by the House of Representatives and is now in the Senate. When the bill was on second reading in the House it was amended in accordance with an agreement between representatives of the architects and of the legislative committee of the Western Society of Engineers. According to H. J. Burt, chairman of the committee, the effect of these amendments is to limit the work of engineers to those buildings which are commonly understood to be engineering structures, such as power houses and manufacturing plants.

Colorado River Can Supply Imperial Valley's Needs

Chief Engineer Rockwood Submits Report Summing up Ten-Year Statistics and Reviewing Irrigation in Lower Colorado

The flow in the Colorado River is ample for all the irrigable lands of the basin in California, Arizona, Utah, Wyoming and Northern Mexico, according to a report submitted by C. R. Rockwood, chief engineer, of the Imperial Irrigation District, to the board of directors of the district on May 29. Mr. Rockwood bases the report on Government and private statistics and speaks also from personal experience with Colorado River irrigation projects since 1893. In conclusion the report states that the present area under canal below the Grand Canyon can use only one-third the water supply, and that a 2,000,000 acre-ft. storage reservoir would insure a supply for every available acre in the same region.

The irrigable acreage above the Grand Canyon is not considered in Mr. Rockwood's computation as to the adequacy of the supply for Imperial Valley, because the areas above the canyon would draw water only during the summer when the river is in flood and the supply more than ample for all needs. In fact, any considerable areas brought under irrigation in that region, he points out, would benefit the lower Colorado by acting as a reservoir in reducing floods and increasing low water flow.

Below Needles, Mr. Rockwood estimates, there are approximately 1,700,000 acres which may eventually require water, 200,000 acres of which are above the Laguna dam. He divides the 1,500,000 acres below the dam as follows: Yuma Project, 100,000 acres; Imperial Valley, 700,000 acres; Lower California, 500,000 acres, and Sonora Mesa, 200,000 acres. The mean flow of the river in each calendar month is sufficient for the irrigation of the entire irrigable area below the Grand Canyon, but when the entire 1,700,000 acres are under cultivation, some storage will be necessary, he states, to furnish an absolutely safe supply for the months of July, August, September and October.

Statistics for Ten Years

Statistics for the ten-year period of 1905 to 1914 inclusive have been carefully studied by Mr. Rockwood and in order to present the matter clearly in the present report he includes a table based on gaging of the Colorado River at Yuma, which shows the mean and minimum values for any month in the ten-year period. The table, which is reproduced herewith, records in the last column the total amount of water delivered by the California Development Company to the Imperial Mutual Companies during each month of 1914.

After explaining the reasons why there need never be fears as to inadequacy of supply Mr. Rockwood states that it will be the flood situation, rather than the necessity of conservation, that will hasten the construction of storage dams. Under the appropriation made last year by the Department of the Interior, surveys have been under way for selecting suitable storage reservoir sites on the upper Colorado, and those already reported upon favorably are as follows: Bluff River reservoir on the San Juan River, Utah, capacity 3,500,000 acre-feet; Bed Rock reservoir on the Dolores River, Colorado, capacity 3,000,000 acre-feet, and the Junction reservoir at the confluence of the Green and Grand rivers, capacity 6,500,000 acre-feet.

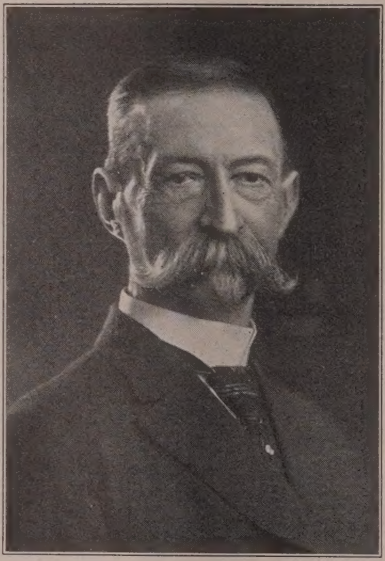
Discharge of Colorado River at Yuma in Any Month, 1905-1914

Month	Minimum discharge, acre-ft.	Mean discharge, acre-ft.	Amount required per acre, acre-ft.	Min. discharge will irrigate, acres	Mean discharge will irrigate, acres	Total used 1914, acre-ft.
January	331,000	598,577	0.177	1,870,000	3,381,000	44,000
February	424,000	741,635	0.189	2,238,000	3,924,000	38,000
March	818,000	1,297,769	0.296	2,763,000	4,380,000	78,000
April	1,060,000	1,618,737	0.317	3,344,000	5,106,000	94,000
May	1,670,000	2,763,975	0.399	4,185,000	6,927,000	113,000
June	2,550,000	4,657,211	0.437	5,840,000	10,657,000	127,000
July	902,000	2,840,610	0.483	1,872,000	5,880,000	135,000
August	580,000	1,328,166	0.404	1,435,000	3,287,000	121,000
September	367,000	861,841	0.354	1,036,000	2,434,000	108,000
October	429,000	784,915	0.265	1,619,000	2,960,000	78,000
November	467,000	599,548	0.175	2,670,000	3,426,000	46,000
December	428,000	653,902	0.160	2,800,000	4,087,000	34,000

Retires After Fifty-four Years in City Service

David Brower, assistant engineer in the Bureau of Sewers, Borough of Brooklyn, city of New York, was retired on pension, June 1, after fifty-four years of continuous service.

Assistant Engineer of Brooklyn Sewer Bureau Who Has Been in Municipal Service Since 1861



DAVID BROWER

He was appointed rodman in the sewer department, May 1, 1861, at the time when the plans of the first drainage system of the first, third and sixth wards of the former city of Brooklyn were being discussed as to whether to build a single or combined sewer system, and when data on such construction and on the local rainfall were very meager.

He was born in Brooklyn, in 1842, was educated in the public schools of the old city of Williamsburg and entered the city service at the age of nineteen. He volunteered for service in the Civil War at the first call for volunteers, entering as a private and retiring, after two years, as a captain.

Pennsylvania Highway Department Changes Engineering Personnel

Important changes in the office forces of the State Highway Department of Pennsylvania were announced June 15. L. L. Robbins, formerly assistant engineer in charge of the district comprising Beaver, Westmoreland and Allegheny counties, has been removed, and S. W. Jackson, formerly in charge of the work in Bradford, Cameron, Lycoming, Sullivan, Potter and Tioga counties, has been appointed in his stead. J. S. Ritchey, formerly superintendent in Sullivan County, has been promoted to the grade of assistant engineer to succeed Mr. Jackson. G. C. Langenheim, formerly in charge of Berks, Carbon, Schuylkill, Lehigh and Northampton counties has been removed and is succeeded by John T. Gephart, Jr. George W. Deaves has been appointed road superintendent of Delaware County; C. E. Myers, of Westmoreland County; W. G. Dick, of Allegheny County, and W. A. Dilzer of Berks County.

Hell Gate Arch Erection Started from Ward's Island

The shoes have been set for the Ward's Island end of the Hell Gate arch of the New York Connecting Railway. Material for the first panels will be unloaded by the shore derrick and hauled to the traveler on the track on which the locomotive crane is shown in the accompanying page of pictures. Part of this material will be rehandled by the crane, as were the castings for the two shoes. After the erection reaches the bank, members will be hoisted directly from the car floats, which is now being done across the river.

Some of the erection methods were briefly described on page 568 of the Engineering Record for May 1, 1915.

May Hold Up Transfer of Link in Alaska Government Railway

Application has been made in behalf of the bondholders of the Alaska Northern Railway for the appointment of a receiver to handle the $1,150,000 which the Government has agreed to pay for this link in its railroad system for Alaska. The bondholders do not oppose the transfer of the property, but hold that the money should be applied to the payment of the bonds.

New England Waterworks Association Names Convention Committee

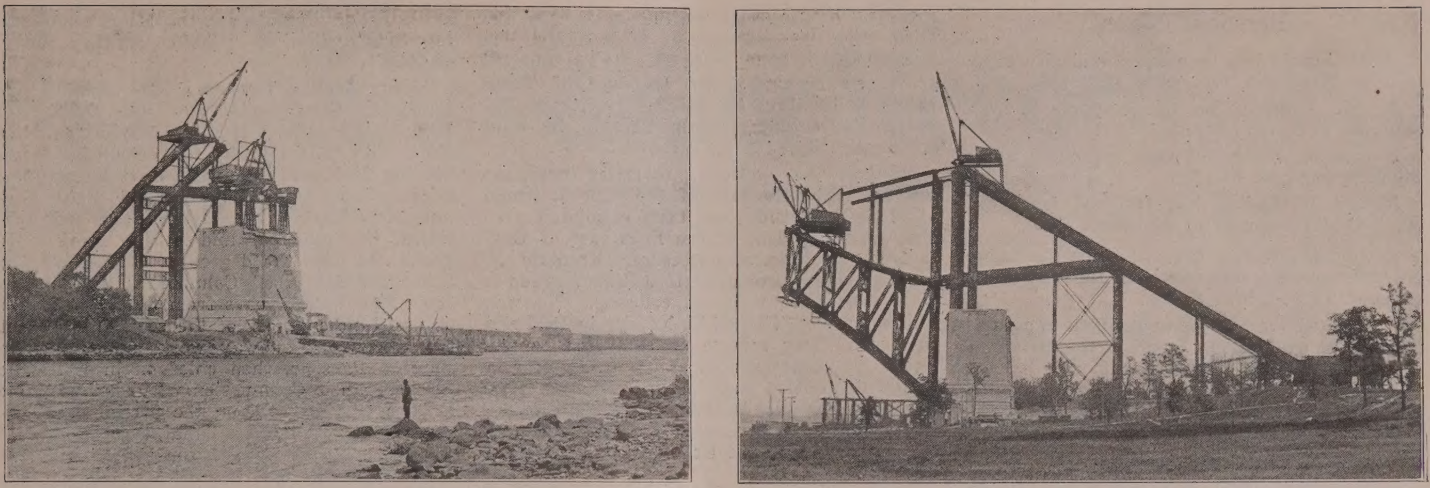
The first steps toward organizing the convention of the New England Waterworks Association which will be held in New York City, Sept. 7 to 9 inclusive, were taken at a meeting in Boston last week when a convention committee was appointed. Alfred D. Flinn, deputy chief engineer of the Board of Water Supply of the City of New York, is chairman and the other members are: William W. Brush, deputy chief engineer, and Henry B. Machen, borough engineer, Department of Water Supply, Gas and Electricity; Francis F. Longley, of the staff of Hazen, Whipple & Fuller, consulting engineers, of New York; Fred S. Bates, sales manager of the Rensselaer Valve Manufacturing Company, and Charles W. Sherman, of the staff of Metcalf & Eddy, consulting engineers, of Boston. In addition to Mr. Bates, who will head the committee on exhibits, another representative of the associate members will be appointed by President Leonard Metcalf.

The Waldorf-Astoria in New York has been decided upon as the convention headquarters and the time of the meeting, Sept. 7 to 9, has been fixed upon so as to make it possible for members to leave for the International Engineering Congress to be held in San Francisco Sept. 16 to 25.

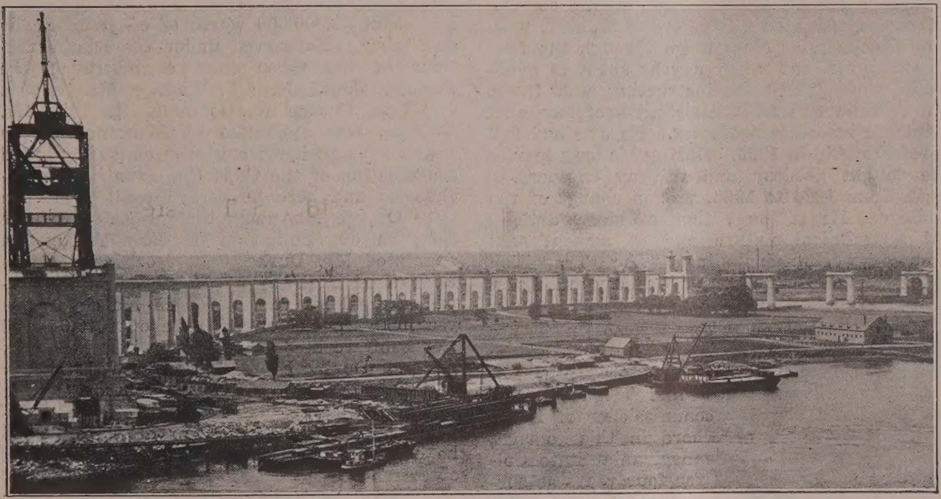
State Highway Department Created in Tennessee

Governor Rye of Tennessee has signed the bill creating a highway commission in that State, to consist of the Governor, the State geologist, the dean of engineering of the University of Tennessee, and three members, each representing a grand division of the State. One of the first duties required of the commission will be the planning of a system of highways connecting all county seats.

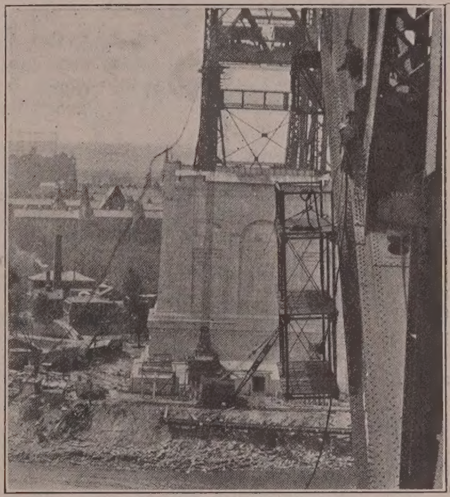
Hell Gate Arch Erection from Ward's Island Started



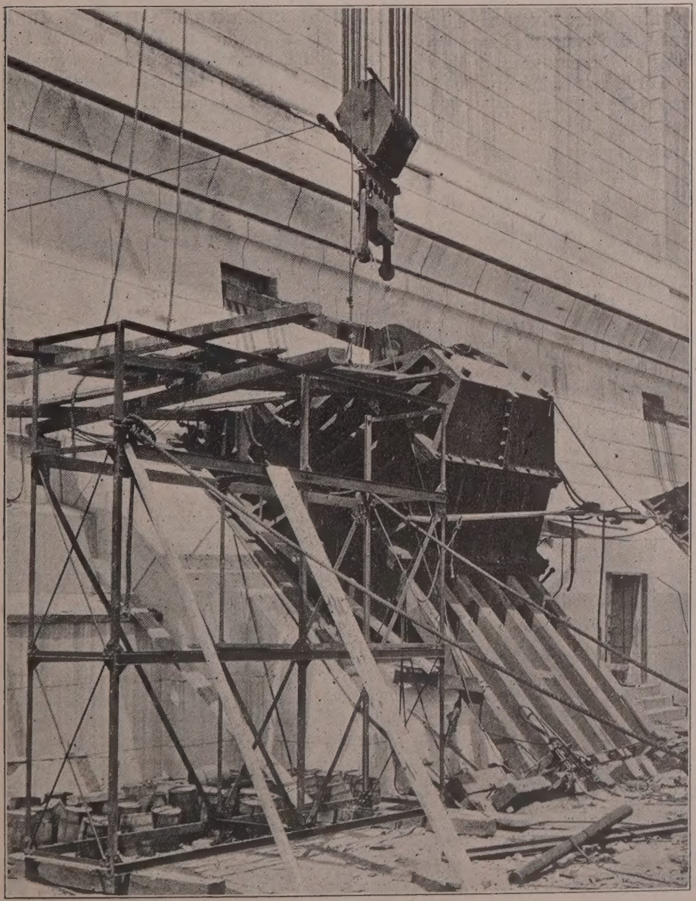
MAIN TRAVELER ERECTED ON WARD'S ISLAND AND FIRST PANEL OF ERECTION TIES PLACED ON LONG ISLAND END



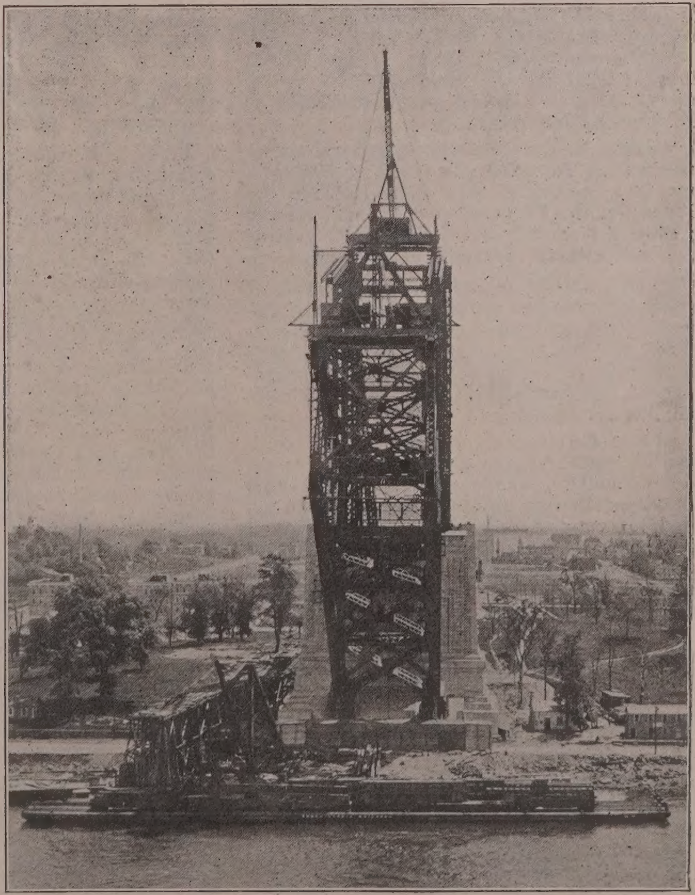
VIADUCT ACROSS WARD'S ISLAND BEHIND CONTRACTOR'S UNLOADING PLANT



READY TO MOVE RIVETING STAGE



WARD'S ISLAND SHOE SET AND TEMPORARILY SHORED



LONG ISLAND STRUCTURE LOOMS HIGH ACROSS RIVER

Left view shows frame of a three-story riveting stage. A car float loaded with steel for the next panel is shown below the main travel at the right.

Personal Notes

C. E. Arnold has been appointed city engineer of Woodland, Cal.

R. W. Fletcher has been appointed city engineer of Vader, Wash.

Eugene M. Booth has been appointed State highway engineer of Idaho.

Russell B. Easton has resigned from the office of city engineer of Aberdeen, S. D.

T. L. Landers has been appointed resident engineer on the Intercolonial Railway with office at Truro, Nova Scotia.

S. T. W. Green has been appointed to a position on the engineering forces of the sewerage commission of the city of Baltimore.

Louis K. Rourke, commissioner of the Department of Public Works of Boston, Mass., and formerly in charge of the Culebra Cut, Panama Canal, has resigned.

C. L. Jarvis, chief engineer of the Provo Reservoir Company, has resigned from that office to become chief engineer of the Sevier River Land & Water Company.

Edwin C. Woodward, paving engineer, of Fort Worth, Texas, and formerly city engineer of that city, has been appointed engineer in charge of paving in the city engineer's department, Galveston, Tex.

William E. Davis, formerly connected with the Ventura Wharf Company, Ventura, Cal., has been appointed assistant resident engineer on a portion of the new concrete State highway between Davis and Sacramento, Cal.

E. Keough, formerly roadmaster and assistant trainmaster of the Chicago, Burlington & Quincy Railroad at Aurora, Ill., has been appointed assistant engineer of maintenance of way of the Canadian Pacific, with headquarters at Montreal.

M. H. Kebabian, formerly connected with the engineering department of the electric division, New York Central Railroad, has been appointed valuation engineer on the forces of the Interstate Commerce Commission, Department of Valuation.

E. O. Christiansen has been appointed engineer of the special tax commission of the city of Cambridge, Mass. He is a graduate of the civil engineering department of the Massachusetts Institute of Technology and a recent student at the Harvard Graduate School of Business Administration.

William M. Brown, formerly general superintendent of the Bangor & Aroostook Railroad, has been appointed chief inspector for the Public Utilities Commission of Maine. He was graduated from Bowdoin College in the year of 1881 and entered railroad service in 1882.

E. E. Ludwick, formerly superintendent of construction on the sewer system, sewage disposal plant and power plant recently completed for the State Hospital for the Insane at Beverly, N. J., has been appointed superintendent of construction on a new municipal building for the city of Philadelphia.

Arthur E. Morgan, in charge of the engineering work for the Dayton Flood Prevention Committee, who passed through a crisis recently, following an operation, is now on the road to complete recovery. It is announced that he will, as soon as he returns to active work, devote all of his time to the Miami Valley work and not, as in the past, only part of his time.

E. A. Byrne, formerly assistant to the chief engineer of the Department of Bridges, City of New York, will head the engineering forces of that department with the title of acting chief engineer, as no chief engineer will be appointed, for the present, at least, to succeed Austin Lord Bowman, whose death was noted in this journal, June 12, the bridge commissioner not deeming such an appointment necessary.

Samuel C. Stickney, formerly assistant general manager of the Erie Railroad at New York, has been appointed assistant to the vice-president of that road, the Chicago & Erie, the New York, Susquehanna & Western and the New Jersey & New York. He was graduated from the Massachusetts Institute of Technology and entered the railway service in 1886 as locating engineer on the Chicago, St. Paul & Kansas City.

William A. Baldwin, formerly assistant general superintendent of the Erie Railroad at New York City, has been appointed general superintendent of the lines east of Buffalo and Salamaca, succeeding Frederic B. Lincoln, whose promotion to a higher grade is noted elsewhere in these columns. He was graduated from Cornell University in 1896 and entered railway service as chairman on the Erie. He was appointed assistant engineer in 1899 and division engineer in 1903. In 1910 he attained the grade of superintendent on the Chicago division and, in 1812, was appointed superintendent of the Delaware and Jefferson divisions.

Prof. Charles L. Crandall, of the college of engineering of Cornell University, retires this month after 41 years of continuous service. He was graduated from Cornell in 1872, with the first regular class to go through the four year course, and, after a year spent in graduate work, joined the instructing staff there. In 1875 he was made assistant professor and, in 1891, associate professor. He attained full professorship in 1895. During his long service he taught geodesy and railway engineering and, from 1904 to 1906, was in charge of the college. He is the author of many articles of a technical nature and of several well known works, including "The Transition Curve" and "Text Book on Geodesy and Least Squares."

Jesse S. Ritchey, whose promotion to the grade of assistant engineer in charge of the district comprising Bradford, Cameron, Lycoming, Sullivan, Potter and Tioga counties by the State highway commissioner of Pennsylvania is noted elsewhere in this journal, was graduated from Pennsylvania State College in 1908 and served for four years as surveyor for the Bureau of Lands, Insular Government of the Philippine Islands. On his return to this country, in 1912, he was appointed chief of party in the Pennsylvania State Highway Department. He served as instructor in civil engineering at Pennsylvania State College from 1913 to 1914, returning in that year to the highway department as superintendent of maintenance.

Frederic B. Lincoln, formerly general superintendent of the Erie Railroad and subsidiary lines east of Salamaca, has been appointed general manager of the lines east of Buffalo and Salamaca, with office at New York City. He entered railway service in 1887 as rodman on the Erie and attained the grade of assistant engineer in 1895. In 1898 he was appointed superintendent of the Tioga division and, in 1905, superintendent of construction on the Delaware & Eastern. Later in the year he became superintendent of construction for the O'Rourke Engineering Company, of New York, on the Grand Central terminal work for the New York Central & Hudson River Railroad. He returned to the Erie in 1914 as general superintendent of the Erie division.

Herbert Nunn, who was city engineer of El Paso, Texas, from 1911 to 1913, has been appointed engineer in charge of permanent highway construction in Multnomah County, Ore., under the recently voted $1,250,000 bond issue. He served with the U. S. Army on topography and reconnoissance work in the Philippine Islands from 1898 to 1900, and took a special course in engineering at the Infantry and Cavalry School, Fort Leavenworth, Kan., in 1905. In 1909 he was appointed special road engineer of El Paso County, Texas, and had charge of the construction of 42 miles of bituminous pavements. During the time he was city engineer of El Paso he had charge of the construction of a reinforced-concrete viaduct, 1257 ft. long, a large municipal plant consisting of a reinforced-concrete warehouse with storage yards and a 125-stall stable, and the design and starting construction of a 36-in. sanitary sewer, 16,000 ft. long.

Henry Welles Durham, who resigned recently as chief engineer of the Bureau of Highways for the Borough of Manhattan, New York City, has entered the consulting engineering field with Percival Robert Moses, electrical and mechanical engineer, 366 Fifth Avenue, New York City. Mr. Durham will specialize in municipal and paving work. He graduated with the degree of C. E. from the School of Mines of Columbia University in 1895, and for six years from that date served as assistant engineer of the sewer division of the New York subway work under William Barclay Parsons, then chief engineer of the Rapid Transit Commission. During this time he also was engaged on the preliminary surveys for the Nicaragua Canal, then under consideration by the Commission which President McKinley appointed. In 1904 Mr. Durham was appointed resident engineer for the City of Panama in charge of the design and construction of waterworks, sewers and paving involving about $1,000,000 worth of construction by day labor. He served under the administrations of the three chief engineers of the Panama Canal, John F. Wallace, Mr. Stevens and Gen. George W. Goethals. In 1907 Mr. Durham was appointed by William Barclay Parsons as resident engineer on surveys and construction of the Cape Cod canal in Massachusetts and here he served until 1911. In 1912 George McAneny, then president of the Borough of Manhattan of New York City, appointed Mr. Durham chief engineer of the Bureau of Highways. He served in this capacity until his resignation in March of this year, having had charge of about $10,000,000 worth of work, $7,000,000 of which was new paving. During his term of office with the city Mr. Durham was detailed by Mayor Gaynor to make an extended trip of inspection of pavements in the principal cities of Europe, and he has published an exhaustive report of his observations.

Obituary Note

Major Alfred B. Putnam, Corps of Engineers, U. S. A., who was in charge of the improvements and maintenance of the Arkansas River and other works within the territory covered by the U. S. Engineer's office at Little Rock, Ark., for the past year, died in that city, June 9.

Civil Service Examinations

Illinois.—The State Civil Service Commission announces that an examination for a service engineer in connection with the Illinois Public Utilities Commission, salary from $200 to $300 a month, will be held July 10; applications to be on file in Springfield on or before July 3. This examination will be unassembled; that is, questions on education and experience will be mailed direct to each applicant, who will write out his replies and return them to the commission. Candidates must be 25 years of age and should have an engineering college education, or its equivalent, and experience or ability in the operation, construction and design of utility properties and their equipment. Familiarity with the Illinois Public Utilities Commission law is also essential. The duties involve directing service inspection of utility properties and preparing orders in such cases.

The commission also announces an examination for an assistant canal superintendent for the Illinois and Michigan canal, salary from $100 to $150 a month, to be held July 10; applications to be on file in Springfield on or before July 3. The examination is open only to residents of Illinois and will be held in the usual places throughout the State. Applicants must be 25 years of age and should have experience in supervision of operation, construction and repair work on canals and their equipment.